Enhancing technical and vocational knowledge and skills of adult learners in Ghanaian universities

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ABSTRACT

This study examines the perceptions of adult learners of the factors that enhance their vocational knowledge and skills in engineering programmes in Ghanaian universities. Using focus-group discussion, we gathered data from adult learners enrolled in telecommunications and electrical engineering programmes in three universities in Ghana. The results show that the technical and vocational knowledge and skills of adult learners are enhanced by an effective pedagogical approach, the application of advanced technology in the teaching and learning process, the development of practice-based experiences and the application of new knowledge to the work environment. The study highlights adult learners' identification of inadequate teaching and learning resources and weak pedagogical approaches in delivering telecommunications and electrical engineering courses as major challenges to the development of the vocational and technical knowledge and skills of adult learners.

KEYWORDS

Adult learners, vocational knowledge and skills, experiential learning theory, higher education

Introduction

Globally, the essential role of technical and vocational education and training (TVET) in national development has been highlighted by various research and policy documents such as UNESCO's Strategy for Technical and Vocational Education and Training (TVET 2016–2021) (UNESCO, 2016). The UNESCO document emphasises the promotion of quality lifelong learning opportunities for all and, importantly, how vital the acquisition of technical and vocational skills is for employment, decent work and entrepreneurship (UNESCO, 2016). Other studies, particularly those from developing countries (Nwogu & Nwanoruo, 2011; Ngor & Tambari, 2017), highlight the importance of TVET for employment, positing that '[t]he importance of TVET to human and national development cannot be over-emphasised' (Ngor & Tambari, 2017:3).

Yet, in Ghana, the implementation of TVET has not been without its challenges. Research findings show that a skills gap still features prominently in industry labour needs (Akomaning, Voogt & Pieters, 2011) and that a lack of resources, including state-of-the-art laboratory equipment and simulators, affects quality TVET delivery in Ghana (Boahin & Hofman, 2012). In relation more specifically to engineering education, challenges include the growing demands of a global industrial environment and the diverse learning needs of students (Henri, Johnson & Nepal, 2017).

The gaps in the education of adult learners – especially in the higher education (HE) sector in Ghana – can be assessed from three major perspectives. The first relates to the paucity of research on the importance of lifelong education as a tool for national development, social change and personal development. Second, while universities in Ghana continue to record an increasing enrolment of adult learners in engineering, especially from the technical and vocational institutes, not much has been done to develop appropriate teaching and learning approaches to meet their peculiar knowledge and skills needs. Third, although universities are expected to provide students with practice-based experiences through students' placement in industries and in laboratory and fieldwork, and the use of advanced technology in the teaching and learning processes, challenges still exist in these areas.

In order to help resolve these issues, this study was undertaken at three universities in Ghana that provide engineering education to students, including adult learners. Furthermore, this article focuses specifically on the factors that could enhance vocational knowledge and skills in engineering programmes in Ghanaian universities from the adult learners' perspective. In the context of the current study, technical and vocational skills refer to the technical knowledge, practical competencies and sound attitudes that are required by adult learners in the engineering field to perform their job functions effectively in their workplace. As HE researchers, we were particularly interested in examining the factors that could enhance the technical and vocational knowledge and skills of adult learners in engineering programmes in Ghana.

For the purposes of this study, we define adult learners as students who did not enrol at university directly after high school but pursued other forms of (mainly in-service) training. Later they entered HE degree programmes as mature students based on their age, work experience, prior entry qualifications and having passed entrance examinations. This study draws on the perceptions of adult learners in telecommunications and electrical engineering programmes at three universities in Ghana in order to identify the factors that could enhance the development of their vocational and technical knowledge and skills in university settings. Earlier studies focused, for example, on redesigning engineering programmes through the application of experiential learning theory (Li, Öchsner & Hall, 2019), whereas Gadola and Chindamo (2019) highlighted the importance of a competitive ground-up project in engineering to promote students' emotional interest, motivation and involvement. Focusing on the link between formal learning and the acquisition of job skills, Römgens, Scoupe and Beausaert (2020) examined the relationship between the employability, workplace learning and knowledge and skills development of students in HE. While these studies focused on the significance of the development of the knowledge and skills of students required for personal growth and economic development, little is known about the factors that enhance the development of the technical and vocational knowledge and skills of adult learners. The current study examines the perceptions of adult learners regarding the factors that enhance their vocational knowledge and skills in engineering programmes at Ghanaian universities.

The study was guided by the following research questions (RQs):

> RQ1: What factors do adult learners perceive as necessary for the development of the vocational and technical knowledge and skills of adult learners pursuing engineering programmes in HE?
>
> RQ2: How can those factors (in relation to RQ1) enhance the vocational and technical knowledge and skills of adult learners in HE to satisfy the knowledge and skills demands of industry?

Ghana as the context of the study

The World Bank (2019) reports that Ghana's economic growth in 2017 was mainly driven by the mining and oil sectors and also stable cocoa production levels that currently make the country the second-fastest-growing economy in Africa after Ethiopia. Growth in gross domestic product (GDP) in the first and second quarters of 2018 was estimated at 5,4% (World Bank, 2019). This economic growth can be sustained through a skilled and knowledgeable workforce that is trained to support the country's developmental agenda. Regarding the provision of education, the qualifications structure of Ghana consists of basic, secondary and tertiary levels of education. According to UNESCO (2019), the basic to secondary transition rate in 2017 was 94,8%, which is quite high. Conversely, with the current tertiary gross enrolment rate at 18,7%, many students who leave secondary schools are not able to transition to tertiary institutions and have to defer their tertiary education to

later in their lives, if at all. This calls for a 'cradle-to-career' system within a national framework that provides opportunities for all categories of learner, including adult learners in tertiary institutions, to obtain essential knowledge and skills through active, consistent and persistent engagement in a learning environment (Lawson & Lawson, 2013).

In spite of the obvious need for adult learners in Ghana to undergo technical and vocational education and training (TVET), various studies reveal that factors such as weak management support, inadequate resources, including training materials, and insufficient pedagogical support from lecturers impede effective training (Boahin & Hofman, 2012); these also combine to reduce the motivation of students to obtain the necessary skills relevant to industry practice. Akomaning et al. (2011) argue that these challenges include gaps in the capacity of higher education institutions (HEIs) to develop the knowledge and skills of students to meet industry and developmental needs.

As part of the reforms in the TVET sector, Ghana introduced the National Technical and Vocational Education and Training Qualifications Framework (NTVETQF) as a sub-framework of the National Qualifications Framework (NQF) in 2012. The aims of the NTVETQF are to (1) bring all post-basic, occupation-oriented qualifications together under a unified qualifications framework; (2) facilitate access to further education and training for individuals in technical and vocational occupations; (3) improve product and service quality by ensuring uniform standards of practice in the trades and professions; and (4) promote access to lifelong learning for all, especially those working in the informal economy (UIL, 2014:2). Table 1 shows the NTVETQF in Ghana with information on the certification level, qualification, status and certifying institutions.

Table 1: The NTVETQF in Ghana (UIL, 2015)

CERTIFICATION LEVEL	QUALIFICATION	STATUS	CERTIFYING INSTITUTION
8	Doctor of Technology (DTech)	Formal	Not available
7	Master of Technology (MTech)	Formal	Technical universities*
6	Bachelor of Technology (BTech)	Formal	Technical universities
5	Higher National Diploma (HND)	Formal	Technical universities
4	Certificate II	Formal	GES-TVET institutions*
3	Certificate I	Formal	GES-TVET institutions
2	Proficiency II	Informal/ Non-formal	NVTI/Informal trade associations*
1	Proficiency I	Informal/ Non-formal	NVTI/Informal trade associations

* ***Notes:*** *The Technical Universities (Amendment) Act, 2016 (Act 922) converted the ten polytechnics in Ghana into fully fledged technical universities. GES-TVET = Ghana Education Service – Technical and Vocational Education and Training; NVTI = National Vocational Training Institute.*

Adult learning programmes have been in existence in Ghana for some time. For example, through its Institute of Continuing and Distance Education, the University of Ghana has developed programmes for adult learners in different fields of study (Tagoe, 2012). Other universities, such as the Kwame Nkrumah University of Science and Technology and the University of Cape Coast, also have structures that support adult learners. In the context of this study, we focus on the development of the vocational and technical knowledge and skills of adult learners who were enrolled for telecommunications and electrical engineering programmes at three Ghanaian universities.

In Ghana, proficiency training in the field of telecommunications and electrical engineering is provided by a variety of technical and vocational institutes and other further education institutions, where students are equipped with practical knowledge designed for industry work. When these individuals, after several years of working, proceed to enrol in HE for additional formal qualifications that cannot be acquired through in-service training, they are compelled to follow the programmes designed for traditional secondary school-leavers. Further evidence suggests that the incongruity between the capacity of HEIs to deliver training that fosters employability and the knowledge and skills demands of industry is a major challenge for the economic development of the country (Akomaning et al., 2011). Although sustained efforts have been made to mitigate the effect of pedagogical and curriculum weaknesses in the structure of adult learning programmes through continuing education (NCTE, 1998), the results show very little effect. The challenges adult learners face are often associated with the pedagogical approaches used by academics in the teaching and learning process that cater primarily for 'traditional' undergraduate students, i.e. school-leavers. However, the learning approach of adults differs from that of 'traditional' students because adult learners mainly develop their knowledge and skills through their rich experiences and often connect these experiences to the learning environment (Martin, 2012).

Experiential learning as a theoretical approach

The history of experiential learning theory (ELT) can be linked to the works of important authors in the 20th century. They include John Dewey, Kurt Lewin, Jean Piaget, William James, Paulo Freire and Carl Rogers, who sought to explain and develop the experiential learning process as well as the multilinear model for adult development (Kolb & Kolb, 2005). ELT derives from the constructivist theory of learning which suggests that social knowledge is created and re-created through the personal knowledge of the learner (Kolb & Kolb, 2005:194). Markedly, ELT is defined as 'the process whereby knowledge is created through the transformation of experience and the combination of grasping and transforming experience' (Kolb, 1984:41). In simple terms, experiential learning often involves an overt intention on the part of the learner to learn (Moon, 2004) on the understanding that learning can take place only with experience (Morris, 2020). The inseparability of learning and experience has been espoused by Moon (2004), who argues that learning involves experiences. However, notwithstanding the assertion that most learning involves experiences, other authors (Beard & Wilson, 2013:17–51) have argued that not all experiences lead to new

insights and learning but, rather, learning takes place when individuals reflect on their experiences.

The ELT model consists of two dialectically connected modes of obtaining experience – concrete experience and abstract conceptualisation – and two dialectically connected modes of transforming experience – reflective observation and active experimentation (Kolb & Kolb, 2005). Accordingly, knowledge is constructed through a creative tension between the four learning modes, which are often presented as an idealised learning cycle where learners are expected to go through a complete learning process of experiencing, reflecting, thinking and acting in a learning setting. To this end, concrete experiences serve as the foundation for observations and reflections on learning, whereas learning is regarded as unproblematic, accessed by the conscious thought of individuals and processed through apprehension (Holman, Pavlica & Thorpe, 1997). Experience is therefore an important aspect of learning, revealing that learning takes place through experience (Morris, 2020). The growing interest in practice-based experiences in HE across the world is, among other things, driven by pressure on HE providers to meet both the needs of industry by training students who have the requisite knowledge and skills to serve those needs and the need for students to obtain an HE qualification (Kennedy, Billett, Gherardi & Grealish, 2015). Essentially, concrete experiences that are gathered by learners during practice-based learning serve as the foundation for the observations and reflections that are required in engineering education (Billett, 2015). Evidence suggests that engineering graduates in the modern era lack the necessary skills – such as strong communication and problem-solving skills, and effective functioning as members of teams – that are essential to solving problems associated with engineering practice (Yadav, Subedi, Lundeberg & Bunting, 2011).

Whereas practice-based learning is essential to developing knowledge and skills in adult learners, this cannot be dissociated from the use of appropriate and effective pedagogy for developing the knowledge and skills of adult learners which is essential to enhancing their vocational and technical competencies. In the context of the current study, effective pedagogy is explained as the adult-learner-centred teaching and learning approaches that aim to develop the knowledge and skills of adult learners through practice-based experiences and the application of new knowledge to the work environment. A previous study has shown that effective pedagogy consists of the process of recognising students as learners and co-creators of learning experiences, as junior scholars and as partners in academic cultures (Senior, Fung, Howard & Senior, 2018). Distinctly, adult learners tend to understand their environment through the formulation of ideas that arise out of interaction, experiences and reflection (Cook-Sather, 2014). Reflection involves the reconstruction of theoretical and professional knowledge obtained from real-life experiences that are transformed through engagement (Usher, 2009). Significantly, reflections are integrated and condensed into abstract concepts from which new ideas and concepts emerge. In the context of our study, reflection involves reconstructing professional knowledge that is gained from experiential knowledge; and the role of a lecturer is to shape the understanding of students about how to blend theory and practice so as to meet the expected learning outcomes.

Other learning concepts are also relevant to adult learners in engineering. For example, through concept mapping (Watson, Pelkey, Noyes & Rodgers, 2016), students link different engineering concepts visually. Furthermore, by way of signature pedagogies (Shulman, 2005), which define the teaching processes that are aimed at developing the knowledge and skills required for professional practice, adult learners are able to develop their vocational competencies. Land (2013) uses the concept of mechanical dissection to explain how teaching and learning could be designed to support the forensic problem-solving aspect of engineering education. Another factor is the application of advanced technology in teaching and learning processes. The complexities of modern work processes stem from the application of advanced technology in the production of goods and the delivery of services in a continuously evolving global space. Importantly, the application of advanced technology (Ogundari & Awokuse, 2018) and innovation (Valero & Van Reenen, 2019) are vital to developing the knowledge and skills of adult learners.

ELT identifies learning as an important determinant of human development and the process by which learning shapes the course of the personal development of individuals. Although there are several advantages associated with ELT, it has some weaknesses. First, ELT has been criticised as being misplaced or over-simplified because of its emphasis on reflection as a separate and primary device that gives meaning to experience – therefore creating a thin line between experience and reflection. Second, the meaning given to a mediated experience remains vague and lacks clarity, especially because experience is socially and historically formed (Holman, Pavlica & Thorpe, 1997). In contrast, Moon (2004) opines that teaching is one of the processes through which learning is mediated and this could be done through face-to-face distance learning or online modes and with tools such as textbooks, electronic resources and journals. In spite of its shortcomings, though, ELT, with its focus on concrete experience and reflective observation, is a useful theoretical approach to adult learning.

The study

In order to investigate the factors that are essential to the development of the technical and vocational knowledge and skills of adult learners in HE, we relied on interviews with participants who were adult learners in three diverse universities in Ghana. We used group discussions to gather information from adult learners in engineering programmes regarding the factors that the participants believed are necessary to develop their vocational and technical knowledge and skills.

Sampling and participants

The population of our study consisted of 129 adult learners who were registered for Electrical and Telecommunications Engineering programmes at three diverse universities in Ghana. We purposely chose three universities that are diverse in size, operations and structure because we sought to obtain a diverse range of responses from adult learners. The universities were one private university (PRU) with a total student population of 5 008, one public university

(PUB) with 42 590 students and one special-purpose regional university (SPU) with a student population of 1 550.

We used a purposive sampling method for recruiting participants for the focus-group discussions. The sample consisted of 27 adult learners (nine participants in groups of three from each of the three universities) who were also employees of different engineering firms in Ghana. Purposive sampling refers to the strategies for selecting participants in a study based on the assumption that particular individuals may hold important views and ideas about a particular phenomenon (Campbell, Greenwood, Prior, Shearer, Walkem, Young, Bywaters & Walker, 2020). To verify the above details, we included the work experience domain in participants' demographical data to obtain information on the number of years that participants had worked in either the telecommunications or the electrical engineering sector. Nine participants indicated that they had industry experience of six to ten years, while eight indicated that they had worked in industry for three to five years and six participants stated that they had worked in either telecommunications or electrical engineering firms for one to two years. A minority of the participants (4) had worked in industry for more than ten years. Table 2 shows the socio-demographic information of the participants.

Table 2: Socio-demographic features of participants (adult learners)

PARTICIPANT	INSTITUTION	PROGRAMME OF STUDY	YEARS OF PROFESSIONAL EXPERIENCE	FIELD OF EMPLOYMENT
RMUA1	Regional University	BSc EEE	2	Private engineering firm
RMUA2	Regional University	BSc EEE	8	Ports and Harbours
RMUA3	Regional University	BSc EEE	2	Private engineering firm
RMUB1	Regional University	BSc EEE	8	Security service
RMUB2	Regional University	BSc EEE	3	Electrical engineering firm
RMUB3	Regional University	BSc EEE	7	Water company
RMUC1	Regional University	BSc EEE	2	Aviation
RMUC2	Regional University	BSc EEE	4	Ports and Harbours
RMUC3	Regional University	BSc EEE	5	Ports and Harbours
PUBA1	Public University	BSc EEE	7	Government ministry
PUBA2	Public University	BSc EEE	5	Cement manufacturing firm
PUBA3	Public University	BSc EEE	13	Electricity company of Ghana
PUBB1	Public University	BSc EEE	2	Private engineering firm
PUBB2	Public University	BSc EEE	5	Government ministry
PUBB3	Public University	BSc EEE	7	Telecommunications company
PUBC1	Public University	BSc EEE	1	Warehouse

Table 2: Socio-demographic features of participants (adult learners)

PARTICIPANT	INSTITUTION	PROGRAMME OF STUDY	YEARS OF PROFESSIONAL EXPERIENCE	FIELD OF EMPLOYMENT
PUBC2	Public University	BSc EEE	16	Electricity company of Ghana
PUBC3	Public University	BSc EEE	9	Educational institution
PRUA1	Private University	BSc Tel Eng	2	Private telecommunication firm
PRUA2	Private University	BSc Tel Eng	3	Vodafone Ghana
PRUA3	Private University	BSc Tel Eng	7	Huawei Ghana
PRUB1	Private University	BSc Tel Eng	6	Aviation company
PRUB2	Private University	BSc Tel Eng	24	Private telecommunication firm
PRUB3	Private University	BSc Tel Eng	13	Energy firm
PRUC1	Private University	BSc Tel Eng	5	Huawei Ghana
PRUC2	Private University	BSc Tel Eng	7	Vodafone Ghana
PRUC3	Private University	BSc Tel Eng	4	Vodafone Ghana

BSc EEE = BSc Electrical/Electronic Engineering
BSc Tel Eng = BSc Telecommunication Engineering

Procedure

In recruiting the participants for our study, we obtained the list of adult learners and their contact details from their course representatives. After that, we contacted 63 students individually by phone to explain the rationale of the study and their role in the focus group. The adult learners who consented to participate in the focus group were then contacted by phone again and an agreed date for the group discussion was scheduled. Each participant was informed about the potential benefits and risks of the study as well as their right to withdraw from the interview. Then the participants were given consent forms to sign before we administered the interview questions and they were encouraged to express themselves freely without any restrictions. We followed the same procedure for conducting the group discussions at all three universities. The duration of each group discussion was between 45 minutes and one hour. Data were gathered through audio-recording devices.

A semi-structured interview schedule was used to gather narrative data from the participants. One of the advantages of using a semi-structured interview schedule in a focus-group discussion is that it enables the interviewers to probe and proceed with follow-up questions where necessary (Walker & Gleaves, 2016).

Questions were designed to elicit information on: the relevance of technical knowledge and skills in the current telecommunications or electrical engineering programme; the teaching methods used by lecturers; whether lecturers challenge students to develop analytical skills,

independent study and application of key concepts to professional roles; whether feedback assists in improving learning activities and developing relevant proficiency in specific areas of improvement; whether the application of technology in the teaching and learning process enhances knowledge and skills; any new technologies or equipment recommended for the university to procure; and the relevant job skills that may have been introduced in the programme.

In order to avoid ambiguities in the questions developed, we undertook a pre-test of the instrument among six participants recruited from the Private University and revised some of the interview questions on the basis of this feedback.

Participants were requested not to provide any personal information that could link them to the data, so as to preserve confidentiality. Furthermore, only the interviewer and the focus-group participants were present in the interview venue while the voice recorders were placed in plain sight of the participants. All the participants were informed about the procedure adopted to process and store the data safely. This process included storing the electronic data on a password-protected computer and the hard copies of the transcripts in a safe. The research project was approved by the Research Ethics Committee of the researchers' home university. In addition, institutional permission was obtained from each of the three institutions from which participants were recruited.

Data analysis

The interview schedule for the group discussions consisted of seven questions, mainly on the factors that enhance the development of the vocational and technical knowledge and skills of adult learners in engineering. We used thematic analysis to examine the narrative data gathered from the participants. One of the advantages of thematic analysis is the theoretical freedom and flexibility (Braun & Clarke, 2006) that it allows researchers in examining complex and rich datasets (Neuendorf, 2019). This process included listening to the audio recordings and transcribing them and then developing the codes, categories and themes from the data (Nowell, Norris, White & Moules, 2017). These steps were necessary to obtain rich information on the participants' perspectives of the factors that enhance their vocational knowledge and skills in engineering programmes at Ghanaian universities. In order to analyse the data, the first step we took was to search the data for important phrases and sentences the participants may have used concerning the factors that would contribute to their vocational and technical knowledge. Phrases or sentences that appeared six times or more were highlighted. Some examples of the codes that were highlighted are: 'laboratories need to be well equipped'; 'connect theories with field'; 'feedback from lecturers'; and 'importance of technology application'.

The second step involved grouping the codes that emerged into categories. For example, 'we receive feedback from our lecturers through emails and report sheets' and 'I receive regular feedback from my lecturers' were collapsed into 'feedback processes and frequency in teaching and learning'.

The third step involved developing the themes based on the patterns that emerged from the codes and categories of the narrative data. Some examples of the themes that emerged were: 'teaching and learning approach'; 'application of new knowledge to the work environment' and 'practice-based experiences'. Making interpretations from analysed data is important to drawing conclusions in research that adopts thematic analysis (Castleberry & Nolen, 2018). One of the reasons for providing detailed information about the processes used in analysing the narrative data was to reveal the methodological thoroughness of the research design and enhance the trustworthiness of the empirical process. Trustworthiness in qualitative research refers to the methodical thoroughness of the research design, the credibility of the researcher, the authenticity of the findings and how applicable the research methods are to future research (Rose & Johnson, 2020).

Results

Analysis of the data resulted in five main themes:

- development of adult learners' technical knowledge and skills in engineering;
- engineering education and technology application;
- teaching and learning approach;
- application of new knowledge to the work environment; and
- practice-based experiences.

Each of these is expanded upon below.

Development of technical knowledge and skills

The first item sought the views of the respondents regarding the ways in which their programmes provide them with relevant technical knowledge and skills that are necessary for appropriate occupational outcomes. A focus-group participant in the public university indicated that

> [t]he introduction of certain core engineering courses in our programme has given us new ideas for our work processes ... most of the theories we learn connect to our work processes and we are able to share ideas with our colleagues and facilitators [PUB3].

A similar view was shared by a participant from the specialist regional university:

> We have been introduced to software for designing engineering tools and for system diagnoses as well as safety in the engineering field which are very important for our practice [SPU3].

PRU7, who was a participant from the private university, highlighted the importance of connecting the theories learnt in class to the fieldwork and also the challenges associated with the lack of modern laboratory equipment:

> For me I am always on the field and so I am used to these modern tools. However, the laboratory tools are very expensive and the university cannot afford [them]. The truth is that I take a lot of lessons from the theories I learn in class to help me apply them well on the field [PRU7].

The feedback from the participants shows that the expectation of adult learners is to be able to connect the theories they learn in the learning environment to their workplace setting. One of the important features of ELT is the creation of knowledge through transforming experiences (Morris, 2020).

Engineering education and technology application

In engineering education, the application of technology in course delivery represents a very important facet of developing the vocational and technical competencies of adult learners, because students are taught content that is not only relevant to their current professional practice, but informs future practice. A participant from the specialist university indicated that

> technology application is important in the marine field. There are modern technologies being used and we must have knowledge of the tools … yes, we have the simulator but the labs need to be well equipped [SPU1].

Conversely, SPU9 decried what he perceived as the challenges students face in developing their skills through the use of modern equipment:

> [O]ur laboratories should be well resourced to enable us (to) acquire the necessary skills in the industry. Presently, we have very few laboratory sessions and, as engineers, we consider this as very inadequate for our skills development. We think that our colleagues reading marine engineering are given preferential treatment because they have a simulator and a state of the art laboratory while we still use our old laboratories [SPU9].

A participant from the private university highlighted some of the challenges by saying that:

> … technology in telecommunication evolves and our employers expect us to be abreast with the changes in the industry. Our challenge now is a lack of well-equipped laboratories with modern equipment [PRU2].

Pressed further, she added that

> [w]e expect to see routers, modernized servers and transmission systems, antennas, signal generators, simulation boards, oscilloscopes and frequency counters [PRU2].

The challenges participants from the public university faced in developing their practical skills were highlighted by PUB8:

> I do not think that I can say anything about the application of technology, the labs or equipment. Remember this is a learning centre so they cannot bring the labs here. If anything, it will have to be at the department lab in Kumasi [PUB8].

For her part, PRU8 touched on the gap between what is taught in class and the practical skills required for the world of work:

> I work in a telecommunication company and I must state that there are new technologies that are currently being used which are not in our laboratories. I think that the university should think of introducing CISCO Networking Certification Training, Complex programming languages and practical field training on transmissions. This will go a long way to help us in our work [PRU8].

Emerging technology and its application in telecommunications and electrical engineering continue to receive wide attention owing to the future of work and the dependence on technology. The data from participants clearly show that adult learners have a deeper understanding of the use of technology in their workplace setting and also expect that they could apply the same technology in the learning environment. However, the lack of well-equipped laboratories serves as a major challenge to the vocational knowledge and skills development of adult learners.

Teaching and learning approach

We then sought the views of participants about the teaching and learning approach used by their lecturers to enhance their knowledge and skills in engineering. A participant from the public university highlighted what he perceived as the practical gaps in the teaching and learning process:

> The teaching methods are okay … the only problem we face is that we do not have enough practical lessons as we expect. The university should employ people from industry to teach us [PUB3].

From the same university, PUB6 was of the view that teachers have different approaches to teaching students:

> Every teacher has his or her own method of teaching. I do not think that they all use the same method. Some teachers are very good when it comes to theory while others are also very good when it comes to practical [PUB6].

A similar view was shared by PUB7, who stated that

> our lecturers can only teach what they know. We will have to work hard and pass the courses. I do not think that the teaching methods will make any difference. Most of us have the practical skills already; what we need is the qualification [PUB7].

A participant from the private university noted that

> [t]he learning activities and outcomes for each course is provided by our facilitators and these often show the activities required of individuals and groups […] and we consider the content of our programmes as very relevant to our professional practice [PRU1].

The challenges adult learners faced in their learning processes were highlighted by a participant from the specialist university, who indicated that

> although we consider the learning activities as important for developing our thinking abilities and learning goals, we do not receive feedback on our assignments from some of our facilitators as expected [SPU5].

This is unfortunate, as any effective teaching and learning process should include feedback mechanisms that allow students to measure their learning through either summative or formative assessment processes. Regarding the intersection between theory and practice, one of the participants from the private university indicated that

> [w]e are able to easily relate the theories we learn in the lecture hall with the field experiences […] this helps us to understand the course better [PRU5].

Another participant from the private university indicated that

> the absence of a modern laboratory for our practical work, internet connectivity for our research and insufficient numbers of relevant Engineering textbooks in the library really affects our study as adult learners [PRU3].

Application of new knowledge to the work environment

The fourth item for discussion focused on the application of new knowledge to the adult learners' work environment. A participant from the specialist university noted that

> [w]e often connect the theories we learn and the relevant fieldwork we undertake to better understand the courses we are taught [SPU3].

Conversely, SPU7 indicated that he could not connect the majority of what he learns at the university to his workplace setting:

> Most of the work we do on the field [is] not related to what we learn here. This is because there are different branches of electrical engineering and it would be important for us to have areas of specialisation [SPU7].

A participant from the public university stated that

> [w]e consider the blend of our experiences and theory as okay … but there [are] always some differences in the way we perceive things. But we are able to understand the theories better because we are on the field [PUB2].

One of the advantages adult learners have at the university is their ability to connect theory with the practical aspect of their jobs. Similarly, they are also able to apply the new knowledge they obtain in the learning environment to the workplace setting.

Practice-based experiences

The last question sought to gather information regarding the development of practice-based experiences of adult learners. A group member observed that

> [t]he university does not place much emphasis on skills development through industrial attachment. Moreover, students who undergo industrial attachment are not awarded credits for the knowledge they acquire from the practical field [SPU4].

A participant from another group opined that

> [i]n my class, we are mostly workers so we often share our practical experiences and ideas during lectures and laboratory sessions … it will not be possible for me to undergo industrial training while I am enrolled in this programme [PUB2].

Conversely, a participant from the private university mentioned that

> industrial attachment is mandatory for us … we are awarded marks when we get attached to industries [PRU3].

Pressed further to explain how she was able to undergo industrial attachment since she was working, she explained that students usually arranged for leave, explaining to their employers the need to obtain experience from other workplace settings.

The responses from the focus-group participants revealed the different structures and arrangements that existed for adult learners in order to develop their practice-based experiences at universities. Conversely, when universities do not make provision for students to receive practical industrial training, it affects the development of their practical skills required for industry work. One of the ways of ensuring that students undergo mandatory industrial attachment is by awarding credits when they complete the attachment process. With changes in global workspaces as a result of the COVID-19 pandemic and the reliance on technology for work activities, there is a need for HEIs in the global sphere to consider upscaling the use of modern technology in the teaching and learning process.

Discussion

An analysis of the data shows that the vocational and technical knowledge and skills of adult learners are strongly enhanced by:

- an effective pedagogical approach in engineering education;
- the application of advanced technology in the teaching and learning process;
- students' development through practice-based experiences; and
- the application of new knowledge to the work environment.

Whereas previous studies had highlighted the importance of TVET to human and national development (Nwogu & Nwanoruo, 2011; Ngor & Tambari, 2017), not much was known about the factors that enhance the vocational knowledge and skills of adult learners in HE. In order to investigate these gaps, the current study used ELT as the theoretical underpinning to examine the ways adult learners studying telecommunications and electrical engineering programmes perceive the factors that enhance their technical and vocational knowledge and skills.

First, whereas the application of advanced technology in the learning process of adult learners is important to developing their vocational knowledge and skills, the findings revealed gaps in the application of advanced technology in the teaching and learning processes in the universities sampled for the study. The lack of advanced technology that is necessary for modern professional practice was highlighted by participants at the specialist and private universities as some of the challenges they faced in developing the requisite knowledge and skills for the world of work. Undoubtedly, the future world of work is characterised by the automation of work processes (Russo, 2020), emerging technologies and the increasing knowledge and skills expectations of employers (Succi & Canovi, 2020) which place greater responsibilities on HEIs to develop structures and systems that support the development of these skills. In relation to ELT, the application of advanced technology both contributes to adult learners' concrete experience and provides them with opportunities for active experimentation. Furthermore, the development of students' knowledge and skills should include the application of technology in work processes (Bucciarelli & Drew, 2015; Ogundari & Awokuse, 2018) that aims at innovation (Valero & Van Reenen, 2019) and economic

development (Borcan, Olsson & Putterman, 2018; Zheng, Hatakka, Sahay & Andersson, 2018).

While it is an undeniable fact that HEIs cannot obtain all the technology needed to train students, through partnerships and cooperation agreements, HEIs could use technologies owned by industries to support their teaching processes. With a growing emphasis on the application of technology in all aspects of production and services (Takala & Korhonen-Yrjänheikki, 2019), the development of the vocational and technical competencies of adult learners to include advanced knowledge in technology has become essential.

The findings of the study show that an effective pedagogical approach is essential to enhancing the development of the vocational and technical knowledge and skills of adult learners in HE. An effective pedagogical approach is of particular importance to create opportunities for abstract conceptualisation. The data analysis also revealed differences in the perceptions of the students about the pedagogical approaches used by the three universities. For instance, issues related to a lack of strong connections between theory and practice – especially those that are related to laboratory activities, feedback on assignments and challenges associated with grasping certain core engineering principles – were highlighted by adult learners at the specialist university. In contrast, although the participants from the private university expressed the opinion that there was a balance between theory and practice in their teaching and learning with the necessary formative and summative assessment processes, they decried a lack of resources – including engineering textbooks, internet connectivity and some laboratory equipment. This particular finding corroborates earlier research by Boahin and Hofman (2012), who argue that a lack of resources such as state-of-the-art laboratory equipment and simulators negatively affects quality TVET in Ghana. And when providers of HE do not emphasise the importance of relevant pedagogical approaches such as simulation (Rooney & Boud, 2019) and strong feedback mechanisms, this could negatively affect the development of technical and vocational competencies. Previous research has shown that the development of an engineering curriculum should, among other things, aim at meeting the needs of learners and providing them with relevant knowledge (Huff, Zoltowski & Oakes, 2016). However, in some HEIs, curriculum planning activities often centre on the internal capacities of the institutions as measured by their teaching staff and internal consultation rather than on labour market requirements (Milutinović & Nikolić, 2014).

Fourth, the application of new knowledge to the work environment represents the last aspect in our framework that enhances the development of the vocational and technical knowledge and skills of adult learners in HE. This relates to ELT's concrete experience and active experimentation. Participants from the different universities opined that they were able to apply to their work activities the new knowledge they obtained from the theory and practical laboratory exercises. The quest by individuals to develop their knowledge and skills through acquiring HE qualifications for the purposes of preparing for future careers remains one of

the reasons for the gradual shift from the conventional liberal notion of HE to higher vocational education (Kennedy et al., 2015). Although growing interest in practice-based experiences is the result of increasing demand by industry for graduates who are skilled and knowledgeable (Kennedy et al., 2015), adult learners often have different expectations: the majority of them are employed by industry and are usually unable to undertake industrial attachment activities outside the learning environment. When education providers do not support the development of the technical knowledge and skills of adult engineering students, the students leave the university environment with very little practical experience required for their occupational activities. This therefore suggests that providers of education will have to design a variety of learning activities that enhance their practice-based experiences. These activities could include discussions about practical experiences in classrooms and laboratories and the use of simulators in the teaching and learning processes.

Finally, the findings of the current study revealed the significance of the practice-based experiences of adult learners that include a process of knowledge reconstruction and reflection, connecting their knowledge and skills expectations to those desired by industry. Prior research revealed the importance of reflection to the learning process of students (Usher, 2009; Cook-Sather, 2014). Furthermore, the transformation of the learning experiences of adult learners requires opportunities for reflection to be created in the learning environment (Morris, 2020) and also outside it, especially in the engineering workplace setting.

The development of technical knowledge and skills in engineering is necessary for adult learners to be able to meet the knowledge and skills expectations of employers. Two main issues stood out clearly from the submissions of the participants from the public and the specialist universities. The first is that the introduction of core engineering courses and software that cover the technical knowledge and skills of engineering students will provide them with new ideas for their work and their professional practice. Second, by introducing adult learners to the relevant theories that connect with their work processes, their learning processes are enhanced and they are enabled to share ideas with their colleagues and teachers. By means of enriched occupational practice in engineering disciplines, adult learners equip themselves for the challenges that come with additional responsibilities when they obtain their degrees. In addition, a structured learning process that recognises a strong relationship between the value of HE and graduates' broader capability sets (Tomlinson, 2018) is essential to the development of the vocational and technical knowledge of adult learners. Furthermore, through effective teamwork, communication skills (Pang, Wong, Leung & Coombes, 2019; Vesikivi, Lakkala, Holvikivi & Muukkonen, 2019) and the diffusion of knowledge and skills to cope with complex work situations (Takala & Korhonen-Yrjänheikki, 2019), adult learners could enhance their performance in the workplace.

These results have led us to develop a framework for the enhancement of vocational knowledge and skills of adult learners that is illustrated in Figure 1.

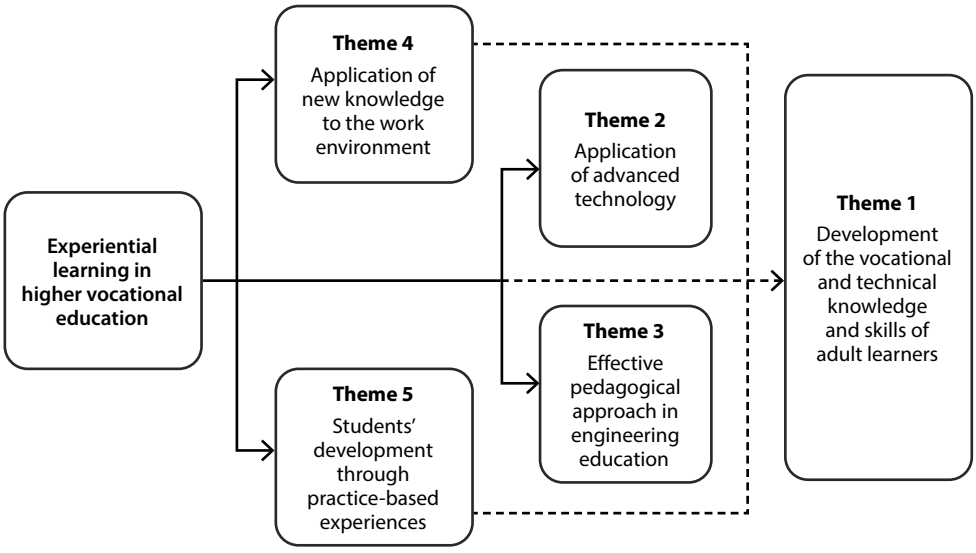

Figure 1: Vocational and technical knowledge and skills enhancement framework (own elaboration)

The first theme highlights the importance of developing the vocational and technical knowledge and skills of adult learners, which is also important to the current study. Second, the application of advanced technology in the teaching and learning environment (Theme 2) is directly linked to the provision of effective pedagogy in engineering (Theme 3). Furthermore, the application of new knowledge to the work environment (Theme 4) and students' development through practice-based experiences (Theme 5) are strongly linked to ELT. The findings of the study as depicted in Figure 1 reveal the importance of a strong pedagogical approach that provides a balance between theory and practice, the application of modern technology in the teaching and learning process and the transformation of students' learning experience through practice-based learning. This outcome further reveals that the development of the professional identities (Billett, 2015) and occupations of adult learners involves an interplay between concrete experiences, observations and reflection that are aimed at enhanced engineering practice.

Furthermore, we extended the significance of practice-based experiences from the development of the professional occupation (Billett, 2015) of adult learners to include a process of knowledge reconstruction and reflection (Usher, 2009; Cook-Sather, 2014) that connects their knowledge and skills expectations to those desired by industry. In complementary ways, transformation of the learning experiences of adult learners requires reflection both in and outside the learning environment (Morris, 2020), especially in the engineering workplace setting.

Study limitations and future research

The findings of this study should be interpreted in light of its limitations. First, although our discussion of the vocational and technical knowledge and skills framework was developed based on the experiential learning theory, other theories could highlight findings different from those that emerged from our study. Future research could explore the application of different theories to the development of the vocational and technical competencies of adult learners. Second, regarding the student respondents, this study relied on data from adult learners at three diverse universities. Future research could consider the views of traditional engineering students on the factors that are necessary for developing their vocational and technical competencies. Finally, the study focused solely on the development of the vocational and technical knowledge and skills of adult learners in engineering. Future research could examine the development of the vocational and technical knowledge and skills of adult learners in other disciplines.

Conclusion

We consider the findings of our study as appropriate at this time, especially when insufficient emphasis is placed on developing the vocational and technical knowledge and skills of adult learners in HEIs. Although on the global front, UNESCO's new strategy for TVET emphasises the promotion of quality lifelong learning opportunities for all as well as the acquisition of vocational and technical skills for employment, its implementation requires a robust framework at the institutional level. First, the current study showed that an effective pedagogical approach, the application of advanced technology, and practice-based experiences enhance the development of the vocational and technical knowledge and skills of adult learners in HE. The study also revealed some challenges confronting HEIs in Ghana with respect to the development of practice-based experiences for adult learners in the engineering discipline. These challenges include a lack of state-of-the-art equipment in laboratories, a lack of opportunities in the current curricula to respond to and fill real work-environment gaps, and what is required for the job setting. In addition, we purposely focused on adult learners in the engineering field in order to highlight those aspects that are relevant in developing the vocational and technical knowledge and skills of a workforce with a view to supporting Ghana's development agenda. Since the present practice of developing engineering programmes based on perceived industry needs alone cannot be sustained, it has become necessary to focus on other factors such as employability skills, advanced technology, and teaching and learning processes that support the development of the vocational and technical knowledge and skills of adult learners.

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