Learning conceptions and priorities of adult engineering students in higher education

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Abstract: The learning conceptions and priorities of adult learners in higher education institutions (HEIs) are essential to explicating the meaning adults make to teaching and learning processes as well as their knowledge and skills development. Through knowledge formulation, comprehension and reflection of what they learn, adult learners develop a mental framework of their learning engagement and experiences which are also relevant to their personal and career development.

Using a mixed method of gathering and analysing data, a survey was carried out among vocational engineering adult learners (n = 200) while focus group discussions were organised for students (n = 27) from the same population. The result showed that teaching and learning methods as well as the relationship between adult learners’ core technical knowledge and skills required for work has a significant effect on the learning conceptions of adult learners in HEIs. Beyond the learning conceptions, the study also revealed that motivation, programme relevance, technology application and employability skills provide a strong framing for elucidating adult learning priorities in HEIs. We present the implications of our findings by showing how they connect to theory, practice and further research.

1. Introduction

Recent discourse in higher education settings have focused on student-centred approaches to teaching and learning as a method of developing the knowledge and skills of students while also ensuring that they create meaning of what they learn in their environment. Consistently concepts such as: students approaches to learning (Monroy & González-Geraldo, 2018; Prosser & Trigwell, 2017); student as producer (Neary, Saunders, Hagyard, & Derricott, 2014); co-creation of curriculum between facilitators and learners (Bergmark & Westman, 2016; Jafar, 2016; Taylor & Bovill, 2018); negotiating co-ownership of learning (Owusu-Agyeman & Fourie-Malherbe, 2018);...
collaborative learning (Northey et al., 2018) and curriculum co-creation as an ecology of participation (Taylor & Bovill, 2018) have dilated the significant role of the learner as a partner, co-owner and co-creator of knowledge in the teaching and learning processes. However, while these concepts seek to enhance students’ engagement and learning experiences in the learning environment, their conceptions of what constitute learning and how their experiences (in the case of adult learners) serve to support their knowledge and skills development remains underdeveloped.

Often regarded as a topical issue in the field of psychology of education (see Vezzani, Vettori, & Pinto, 2017), the conceptions of learning especially among adults in higher education institutions (HEIs) are essential to their knowledge and skills development due to the following: 1) they define a coalescence of prior knowledge theories, skills, experiences and expectations of what they consider as learning; 2) they represent the mind frame and thought patterns of adult learners and how they define new knowledge and skills and their application in the learning environment and 3) they position learners to internalise the learning processes through social learning.

Markedly, the conceptions of learning among adults differ from other category of students because adults carry along rich experiences that often serve as building blocks for their learning and secondly, they identify new knowledge and skills that are relevant to their personal and professional advancement. Päuler-Kuppinger and Jucks (2017) posit that knowledge and skills acquisition in the learning environment is enhanced when both players (teachers and students) identify their unique conceptions of learning. Beyond the unique conceptions of adult learners, they are also regarded as voluntary learners who tend to be attracted to learning experiences that benefit them (Knowles, 1996; Martin, 2012; McLinden, 2013). The learning environment of adult learners is very important to their conceptions because it explains the social settings from which emerge their thoughts about new knowledge and their application in real-life context. Jarvis (1987) argues that learning always starts with social experience which also defines the foundational knowledge, beliefs and norms of a group. Importantly, learners could be located in their socio-cultural setting and the best way in constructing any theory in adult learning will be to consider these settings namely: the actualised subculture of a local society, the learners’ position in the community and the means by which knowledge is conveyed to individuals (Jarvis, 2004). Focusing on the means by which knowledge is conveyed to individuals through their understanding of both the social and epistemic processes, the authors explore the factors that enhance the learning conceptions of adult learners in a higher education setting.

Previous studies have focused on: the differences in the conceptions of learning among learners with diverse learning experiences (Säljö, 1979); identifying the conceptions of learning as an array of thought patterns with different stages of development (van Rossum, Deijkers, & Hamer, 1985); investigating how gender, academic area, and level of study influence students’ conceptions of learning (Vezzani et al., 2017); and gaining insight into discrepancies between conceptions of and approaches to learning by way of a qualitative and quantitative research processes (Monroy & González-Geraldo, 2018). This study, however, adopts a constructivist approach to extending previous research by conceptualising the learning conceptions and priorities of adult learners in HEIs. Knowles (1996, p. 83) suggests that knowledge transmission among adults should rather be known as “lifelong process of discovering the unknown”. Therefore, in arriving at an empirically informed argument regarding the aggregated effect of the conceptions of learning among adults in HEIs, the authors sought answers to two important questions: 1) what factors influence the conceptions of learning and priorities of adult learners studying engineering programmes in HEIs? and 2) how can the learning conceptions and priorities of adult learners enhance their knowledge and skills development in HEIs? The authors chose two engineering programmes—telecommunications and electrical engineering programmes primarily because we identified the telecommunications and energy sectors as industries with high growth rate and increasing knowledge and skills demands from employers.
The authors discuss the conceptual model by way of a two-prong approach—adult learners' conceptions and priorities. The learning conceptions: core knowledge in engineering; teaching and learning methods and the interplay between the core technical knowledge required for work are gauged in relation to the learning priorities. The learning priorities: motivation, the relevance of engineering programmes, technology application and employability skills are also discussed to reveal the different aspects that either promote or hinder the knowledge and skills development of adult learners in HEIs. Through the views and experiences of adult learners who were pursuing telecommunications and electrical engineering programmes in three universities in Ghana, we discuss the extent to which the learning conceptions and priorities of adult learners are shaped in the HEI environment.

2. Theoretical review
Several authors have argued that there are no universally accepted definitions of adult learning (Merriam & Brookett, 2007). However, whereas different theories are used to discuss adult learning processes and practices, other authors (see Hillier, 2002; Illeris, 2003; Ormrod, 2000; Preece & Hoppers, 2011) describe adult learning as a structured process that allow adult learners to acquire knowledge, skills and attitudes. The constructivist theory, however, serves as the theoretical underpinning of this study. Consistent with constructivism (Fry, Ketteridge, & Marshall, 2009; Scheerens, Luyten, Steen, & Luyten-de Thouars, 2007; Usher, 2009; Yilmaz, 2008), the authors argue that adult learners develop their knowledge through comprehension, reflection and active engagement with the learning processes. Through the formulation and reformulation of ideas and reflection, adult learners are able to develop new ideas (Fry et al., 2009) thereby, making meaning of their environment. Knowles (1996), however, emphasise that adult learners' perspectives of their learning are primarily shaped by their experiences that is reinforced through interpretation and reflection of their environment. Additionally, Andragogy (Knowles, 1996), which defines the process of developing the knowledge and skills of adult learners through active participation and curriculum co-ownership, exemplifies the learner-centred approach to teaching and learning. Importantly, andragogy as a theory identifies the importance of developing a conducive learning environment including planning adult learning programmes with adults and engaging students in the evaluation of the teaching and learning.

We argue that the learner-centred approach to teaching and learning provide credence to the development of the mental frameworks of adults through their conceptions of learning while their learning priorities are also shaped by social, environmental and institutional factors. Although proponents of constructivism (see Usher, 2009; Yilmaz, 2008) explain that the teaching and learning processes are important in developing an effective environment for knowledge sharing, behavioural theorists share different opinion. In contrast, the behavioural theorists posit that the behaviour of individuals in learning could be best shaped through conditioning (Jarvis, 2004). Additionally, unlike the constructivist approach, the behavioural theory suggest that conditioning is based on the idea that knowledge acquisition derives from the reactions of individuals to stimuli from the environment and that learners can only obtain mastery of an exercise through repeated processes. Although behaviourism could be useful especially in educational approaches such as competency-based learning, problem-based learning, instructional design and simulation (see Keating, 2015), it does not allow for deeper refection that is necessary in developing learning conceptions. While behaviourism are essential in developing the knowledge and skills of adult learners, the authors posit that constructivism strongly explicate how adult learners integrate new knowledge and accumulated experiences over a period of time (Biggs & Tang, 2007; Scheerens et al., 2007; Yilmaz, 2008) while making meaning of what they learn.

3. The conceptions of learning
Learners in HEIs including adults formulate and reformulate the theories that are introduced to them in their learning environments (Barkley, 2009; Sambell, 2011; Tennant & Pogson, 1995) thereby, developing strands that connect the theories learnt with their experiences by way of the conceptions of learning. Previous study by Säljö (1979, p. 446) show that the conceptions of
learning among adults are determined by: the amount of information they receive; the abstraction of meaning to new knowledge and information; their ability to memorise notes and theories; their acquisition of new ideas; their ability to understand what they are taught; and how they identify learning as an object of reflection. The development of conceptions of learning is driven by social factors that influence educational systems across different countries. The knowledge, beliefs and norms which constitute the culture of the social group (Jarvis, 2004) also define how socialisation plays an important role in the development of the learning conceptions of adult learners. Similarly, Loureiro and Coria (2013) posit that the transmission of knowledge and action takes place through socialisation which is often done by way of participation in practice.

While Säljö (1979) provides five main determinants of the conceptions of learning, van Rossum et al. (1985, p. 618), on the other hand encapsulate the conceptions of learning into two categories: reproductive and the constructive views. The reproductive view of the conceptions of learning is explained as the acquisition of knowledge, the memorisation of content and the learning of algorithmical applications of a specific knowledge. The constructive view of conceptions of learning on the other hand suggest that learning involves: the abstraction of meaning and a process aimed at interpreting and understanding reality (van Rossum et al., 1985, p. 618).

Although studies by Säljö (1979) and van Rossum et al. (1985) explicated important elements that influence the conceptions of learning among learners, the application of digital learning systems and the increasing shift from the traditional face-to-face learning to both blended and online learning systems have altered the learning environment. Additionally, the socio-cultural factors that influence the conceptions of learning among adult cannot be discounted. More recent studies by Vezzani et al. (2017) advance the learners’ conception argument by emphasising gender, academic area and level of study as factors that influence students’ conceptions of learning. Similar study by Monroy and González-Geraldo (2018) also revealed the importance of examining the differences between conceptions of and approaches to learning. The conceptions of learning are, however, essential for all categories of learners because they explain how learners receive, process and apply information they receive while studying. In providing an operational definition of the learning conceptions of adults, the authors suggest that the concept explicates the mental framework that consist of core knowledge acquisition, reflection, teaching and learning processes as well as the technical knowledge and skills required for work. Additionally, we argue that the conceptions of learning among adults are further explicated by their knowledge and skills priorities that consist of programme relevance to adult learners’ goals, adult learners’ motivation, technology application and employability skills.

4. The conceptual model

Drawing from the theoretical review, the authors developed three key indicators that influence the learning conceptions of adults in higher education: core knowledge in engineering (CKE); teaching and learning methods (TLM) and the interplay between the core technical knowledge required for work and the skills (COJ). Additionally, we developed four other factors that served as priorities for adult learning in HEIs: the relevance of engineering programmes to adult learners’ goals (PRA); adult learners’ motivation (MOT); technology application in the teaching and learning processes (TEC); and employability skills (EMS). The learning conceptions of learners (LCL), however, served as the dependent variable while the remaining seven served as dependent variables. The authors explicate how the conceptions of learning among adult learners could serve as the basis for enhancing the teaching and learning processes.

The first factor in the conceptual model is the teaching and learning methods. In conceptualising adult learning processes, we posit that constructivism serves to explicate how adults learn by integrating new knowledge and accumulated experiences over a period (Ramsden, 2003; Yilmaz, 2008) in the learning environment. Importantly, constructive alignment (Boev, Gruenwald, & Heitmann, 2013) which describes how facilitators apply teaching and learning methods in classrooms that do not rely on the traditionally known methods are also important for adult learners.
However from a behaviourist perspective, Light and Cox (2001) argue that the role of the facilitator, which includes controlling the teaching and learning processes in the learning environment are often discounted by constructivists. Critical elements such as appropriate learning resources, course content, student-facilitator interaction, network relations, timelines, practical field work, progression level, order of presentation of material, pace, programme logic, laboratory work, location and negotiation of programmes define the expectations of adult learners (Cook, 1992; Frith, De Jong, & Vansteenhuyse, 2012; Hillier, 2002; Jarvis, 2004; Martin, 2012) in the teaching and learning processes.

The knowledge derived from active engagement with theory and practical lessons is what we refer to as core knowledge in engineering in this study. Säljö (1979) and Van Rossum et al. (1985) suggest that acquisition of new ideas and the abstraction of meaning to new knowledge are essential in identifying the conceptions of learners. The knowledge acquired by learners could be described as an epistemological process (Päuler-Kuppinger & Jucks, 2017; Shay, 2013; Wheelahan, 2007) that enable them to comprehend the theories and practical lessons. Learners’ conceptions are either “thematised” or “taken-for-granted” (Säljö, 1979, p. 446). Importantly, while the “thematised” conceptions of learning is characterised by self-actualisation, reflection and the relationship between learning and professional practice, the “taken for granted” conceptions of learning denote a process where learners only memorise and reproduce what they learn. However, the core knowledge and skills expectation of adult learners are enhanced by factors such as learning resources, adult learners’ support systems, learning objectives and outcomes for each course, teaching and learning activities, development of relevant graduate attributes, provision of assessment tasks and grading standards and the providing conducive learning environments (Angelo, 2013; Thijs & Van den Akker, 2009). Importantly, Heitmann (2005) suggests that the knowledge and skills of learners in an engineering environment should rather aim at developing the knowledge and skills of learners while meeting the skills needs of industry.

The learning conceptions of adults are partly influenced by the interplay between the core technical knowledge required for work and the skills that show how they respond to workplace issues and address them. Van Rossum et al. (1985) suggest that the conceptions of learning are derived from processes aimed at interpreting and understanding reality. Additionally, they suggest that this process includes the learning of algorithmical applications of a specific knowledge. The knowledge acquired by adult learners in the classroom environment could be put into practice through expansive learning where they actualise new knowledge through application and second, through fieldwork where emphasis is placed on skills acquisition. The learning conceptions of adult learners, therefore, should integrate structured knowledge (which we define as core knowledge) to explain real-life issues that arise from work situations and processes (Huff, Zoltowski, & Oakes, 2016; Land, 2013). Furthermore, the balance between theoretical knowledge and practical skills requires individuals to be creative and relate modern technology to real-life situations to solve problems (Boev et al., 2013; Crawley, Malmqvist, Östlund, Brodeur, & Edström, 2014; McLinden, 2013; Romiszowski, 2016; Svinicki & McKeachie, 2010).

### 4.1. Learning priorities

Adult learners’ motivation to obtain higher qualifications is essential to their learning priorities. Six major factors affect motivation of adult learners; “attitudes, needs, stimulation, emotion, competence and reinforcement (Wlodkowski 1985 as cited by Jarvis, 2004). Importantly, Martin (2012) suggests that motivation is a necessary process that shapes the intellect and behaviour of individuals while sustaining their actions. In conceptualising the rationale of adults’ enrolment in engineering programmes in HEIs, three key factors are considered by the authors: social background, economic exigencies and individual aspiration. While social background and individual aspirations relate to the benefits adults may derive from enrolling in a higher education programme that enhance their status and contribution to the development of their communities through social engagement, the economic factor are often linked to financial rewards. The
economic motivations of adult learners to acquire advance qualifications are defined by the consumption and investment factors (Kaiser & de Weert, 1994).

The relevance of engineering programmes to the knowledge needs of adult learners is very important chiefly because they define the outcome of adult learners’ engagement in the teaching and learning processes. Cook (1992) suggests that the knowledge and skills expectations of adult learners are regenerated by their ability to negotiate their curriculum in four main ways: learner resources and commencing point; engagement of their intention to learn; exploration and experience in the learning area; and reflection and consequences. However, when adult learners are allowed to make suggestions in the development and execution of programmes, it promotes teaching and learning processes through a collaborative approach with education providers and regulatory agencies (Cook, 1992; Hunt, Chalmers, & Macdonald, 2013; p. 31).

4.1.1. Technology
It plays a very important role in the teaching and learning processes of adult learners in higher education. Crawley et al. (2014, p. 2) and Heitmann (2005, p. 447) espouse the importance of reviewing the structure of engineering programmes in-line with emerging technologies as a response to changing demands from industry; providing students with the knowledge and skills relevant for industries and making learners more responsive to the demands of employers. The field of engineering requires the application of structured knowledge to resolve complex issues (Land, 2013; Moore & Voltmer, 2003) while the expectations of industry and society for practitioners is that, they should be creative and up-to-date in the application of technology (Case, 2008; Svinicki & McKeachie, 2010). The application of technology in the teaching and learning of adults ensures that elements of enquiry and problem-based learning, practical work illustrations, web-based laboratories applications and computer-aided assessments (Heitmann, 2005; Romiszowski, 2016) are integrated in the curriculum.

4.1.2. Employability
Employability in the context of educational settings is essential because, “improvements in educational outcomes have been widely recognised as essential to enhancing growth in both developed and developing countries” (Holland, Liadze, Rienzo, & Wilkinson, 2013:12. Several authors (Barrie, 2004; Crebert, Bates, Bell, Patrick, & Cragnolini, 2004) suggest that writing and presentation skills, communication skills, problem-solving methods, analysis and teamwork are some aspects of generic skills that employees require employers to possess. Additionally, they suggest that industrial attachments provide relevant opportunities for students to develop these skills and apply them at their workplace.

4.2. Research questions and hypothesis
To investigate the phenomenon and explore the relationship between the different variables in the study, we first developed two research questions; RQ1—what factors influence the conceptions of learning and priorities of adult learners studying engineering programmes in HEIs? and RQ2—how can the learning conceptions and priorities of adult learners enhance their knowledge and skills development in HEIs? We then proceeded to develop the following research hypothesis to provide answers to research question 1:

Hypothesis 1

H1a: There is a statistically significant and positive relationship between adult learners’ conception of learning and their core knowledge in engineering.

H1b: The learning conceptions of adult learners’ are positively enhanced by the interplay between the core technical knowledge required for work and the skills.

H1c: Adult learners’ conceptions of learning are significantly enhanced by the teaching and learning methods used.
Hypothesis 2

H$_{2a}$: There is a statistically significant and positive relationship between teaching and learning methods and the ability of adult learners to apply technology in class and on the field of work.

H$_{2b}$: Adult learners’ core knowledge in engineering is enhanced by the teaching and learning methods.

H$_{2c}$: Employability skills are positively influenced by the teaching and learning methods.

H$_{2d}$: There is a statistically significant and positive relationship between adult learners’ motivation to enrol in higher education and the teaching and learning methods.

Hypothesis 3

H$_{3a}$: There is a statistically significant and positive relationship between the relevance of adult learning programmes and their motivation to acquire further qualification.

H$_{3b}$: Adult learners’ core knowledge in engineering is enhanced by the relevance of adult learning programmes to their individual goals.

H$_{3c}$: The interplay between the core technical knowledge required for work and the skills is enhanced by the relevance of adult learning programmes to their individual goals.

5. Methods

This study adopts an explanatory research design to investigating the learning conceptions of adult learners’ in three different universities in Ghana. Additionally, explanatory research design was followed to examine the underlying factors that influence adult learners’ conceptions of learning as well as their learning priorities in the learning environment. Previous studies by Monroy and González-Geraldo (2018) sought to identify convergence in quantitative and qualitative responses of individuals when measuring their conceptions of and approaches to learning by way of a mixed method. A mixed method of collecting and analysing data was followed. Several authors (Cohen, Manion, & Morrison, 2011; Creswell, 2008; Yin, 2009) have espoused the benefits of using a mixed method of collecting and analysing data.

5.1. Participants and setting

The study population was 49,148 students in three different universities in Ghana with the breakdown as follows: one public university (42,590 students); one regional university (1,550 students) and one private university (5,008 students). Two different sampling methods, probability and non-probability sampling, were used in this study. Probability sampling method by way of simple random sampling was used to select adult learners for the survey while non-probability method by way of purposive sampling was applied to gather interviewees for the focus group discussion. The sample size for the study was 343 adult learners with the breakdown as follows: Public University (PUB)—188; Private University (PRU)—84; Specialist (regional) University (SPU)—71.

5.2. Instruments

We developed a questionnaire and focus group interview schedule for the data collection exercise. The survey consisted of 30 questions grouped under nine main sections: the demographic information; relevance of programme to individual goals; adult learning conceptions; core knowledge in engineering; motivation to acquire further qualification; technology application; interplay between the core technical knowledge required for work and the skills; teaching and learning methods and employability skills. The survey respondents were required to provide their responses on a 5-point Likert scale, where 1 represented “strongly disagree” and 5 represented “strongly agree”. The demographic information, however, required respondents to provide their answers using an open-ended question structure. The focus group discussion schedule on the other hand consisted of four main items: the adult learning programme structure; teaching and learning methods in relation to their learning conceptions and priorities; core knowledge in engineering; and technology application.
5.3. Procedure

We administered a total of 240 self-report surveys to adult learners and out of the total survey items, we received 213 responses. The valid responses from the survey items we received were 200, which indicated a valid response rate of 83.33%. Totally, 30 adult learners participated in the focus group discussion, and they were selected from the four analytical units used for the study. The number of male respondents was 182 representing 91%, while female respondents were 18 representing 9% completed the questionnaires. In total, 27 adult learners made up of three groups from each university participated in the focus group discussions and the same procedure for gathering information from the participants was repeated in all the discussions held among the different groups. The age distribution \( M = 33.7, SD = 7.08 \) shows that majority of adult learners studying engineering programmes across the three universities are early adult learners with industry work experience of between 0 and 10 years. The average number of years the respondents had worked in industry \( M = 9.5, SD = 5.14 \) revealed that they had accumulated adequate experience in their profession.

Before we administered the interview schedules and questionnaires, we undertook a pre-test to ensure that the respondents and focus group participants understood the questionnaires and that discussion items without challenges. This measure was undertaken to strengthen the reliability of the datasets. Reliability of the constructs in the survey instrument was derived using Cronbach’s Alpha (we provide details of the reliability and validity of the datasets in the discussion and analysis section) while we applied crystallisation in the development of codes, patterns and themes that reifies the conventional qualitative data analysis process. Furthermore, we adopted triangulation (Arksey & Knight, 1999; Gray, 2009; Nieuwenhuis, J, 2012) to strengthen the trustworthiness of our research. This was carried out by checking the extent to which the study findings were based on the focus group discussions and survey responses and comparing the results to each of the sources. The internal and construct validity were ensured by way of a careful development and administration of the survey instruments and focus group interview schedules that were open and non-prejudicial (Cohen et al., 2011). The data gathered were analysed by way of conventional qualitative and quantitative techniques that have been espoused by some authors (see Cohen et al., 2011; Creswell, 2008; Yin, 2009). We analysed the survey data by using the analysis software Amos while the focus group discussions were analysed through a process that included content analysis, pre-coding, coding and the development of themes.

To satisfy the rules of ethical consideration, the researchers obtained written permission from management of the three universities before administering the questionnaires and conducting the focus group discussions. The focus group participants and survey respondents were contacted by the researchers prior to collecting data from them while the date for the discussions was also agreed with the participants. The contact details of the participants were obtained from the institution mostly through the class representatives. All respondents and interviewees were given consent forms to sign, indicating their willingness to provide information for the study. Additionally, care was taken by the researchers to ensure the confidentiality of the information provided by respondents, as well as the safe storage of the datasets gathered.

5.4. Measures

Using principal component analysis (PCA), we assessed the distinctiveness of the factors (CKE, PRA, LCL, MOT, TEC, COJ, TLM and EMS) that explicate the conceptions of learning and priorities of adult learners in three universities. Three constructs—PRA, CKE and MOT—were adapted from Owusu-Agyeman, Fourie-Malherbe, and Frick (2018) while the remaining constructs (LCL, TEC, COJ, TLM and EMS) were developed from the theories discussed. Factor analysis served as a dimension reduction method of multivariate statistics that sought to analyse the latent variables from manifest variables (see Cohen et al., 2011; Tzeng, Chiang, & Li, 2007) in the study. We proceeded to compute the absolute fit indices that sought to test the extent to which the eight-factor priori
model suits the data from the sample used (see McDonald & Ho, 2002). Subsequently, we computed the chi-square statistics and fit indices of RMSEA, CFI and TLI (see Hair et al. 2014).

6. Results

6.1. Focus group analysis

The qualitative data analysis primarily sought to provide answers to RQ2: how can the learning conceptions and priorities of adult learners enhance their knowledge and skills development in HEIs? The first item for discussion under RQ2 sought to glean from the respondents how their programmes had been designed to serve their learning needs which we considered as essential to their learning conceptions and priorities. One of the groups stated that, “our present programmes provide us with opportunities to develop relevant skills needed for our profession...and we consider that as very important to our learning” [PBU]. Another group noted that “although we acquire theoretical knowledge and some practical knowledge, our expectation is that lecturers would have additional practical knowledge when teaching. It helps us ask questions and seek further explanations to the theories” [PRU]. The role of industry in the development of courses was also stressed by some of the respondents. “There should be consultations between university authorities and employers in the Telecommunications industry and such consultations should result in identifying courses and key skills needed for specific types of jobs in the industry” [PRU]. The priorities of learning among adults are also influenced by their motivation to obtain further qualification and, to some extent, have input in the learning processes. The participants noted that, “although we are motivated to study our programmes, we only enrol and follow the structure of the programme...due to our tight schedule we do not have the time to alter our schedule” [PBU]

The participants were required to provide relevant information regarding the teaching and learning methods and how they could enhance the development of their conceptions as adult learners. The first question sought to find out from the participants how the learning goals were discussed in class to suit their learning needs. One of the groups noted that, “the learning goals including the expected activities for each of the courses are clearly spelt out at the commencement of each course and we understand what our lecturers teach” [PBU]. They added that, “the courses are flexibly structured and it allows us to combine our work and studies effectively although we do not have separate syllabi from those used by the mainstream students”. With respect to feedback systems, one of the groups noted that “through verbal means when we meet with lecturers, they provide us with the clarification of the issues that were not addressed in our previous class” [PBU]. Another group also noted that “the feedback systems are not very consistent. We hardly receive our assignment sheets (projects/take home assignments) from our faculties...the feedback systems are irregular and there are no regular feedback sessions...this however does not offer us the right information we need to build on what we learn and apply them in our work environment” [SPU]. One of the groups noted that “we are often introduced to new theories which are important to our learning...however some of the theories and principles require practical demonstration which are not often available” [PBU]. Another group, however, indicated that “we often reflect on what we are taught because most of us apply the theories we learn in our work places...although some of the theories are not directly related to what we do, we consider them as important because they explain the principles underlying certain design systems and machine functioning” [PRU].

Participants discussed their conceptions of learning with respect to their core knowledge in engineering. A group indicated that “management should consider redesigning our courses to reflect technological development all over the world...we consider some of the course content as very general although we are required to apply them” [PBU]. Another group opined that “the university does not place much emphasis on skills development through industrial attachment” [SPU]. The last group opined that “extensive laboratory work, information theory and advanced computer programming are essential in the development of the knowledge and skills of adults” [PRU]. The views of the students suggest that adult learners’ core knowledge in engineering could
be enhanced through practical field sessions where students are made to apply the theoretical knowledge acquired in the classrooms and the redesigning of courses to reflect growing workplace knowledge and skills needs.

The participants were asked to indicate the new technologies and equipment that they considered relevant for their work processes. The PRU opined that “we consider simulation software for electrical field work as a very useful addition”. Another group indicated that “routers, new and modernised servers and transmission systems as well as state of the art laboratories are very important to us as workers”. The relationship between core knowledge in engineering and technology-enhanced learning was espoused by the PRU respondents who stated that courses such as base installation if added will increase our efficiency at work and help us apply modern technology in resolving transmission related activities. ... additionally, we will be very confident when using new technologies at our work places [PRU].

The focus group discussions provide relevant information on the factors that enhance the learning conceptions of adults in higher education.

6.1.1. The measurement model

We followed a series of PCA to test the uniqueness of the variables while the measurement model for the theoretical structure was computed to show the reliability and validity of the indicators (see Chin, 2010; Hair, Hult, Ringle, & Sarstedt, 2014). The hypothesised causal relationships with respect to adult learners’ conceptions of learning and priorities were tested among the theoretical constructs using the analysis software SPSS v.20. Importantly, prior to developing the structural model, the authors ensured that the assumptions of univariate normality, positive definiteness and multivariate normality were not violated.

First, to determine the reliability of the construct measurements, Cronbach’s alpha (α) and composite reliability were computed and compared with the recommended values. All the constructs used for the study demonstrated acceptable internal consistencies (αCKE = 0.86, αPRA = 0.85, αMOT = 0.80, αTEC = 0.82, αCOJ = 0.79, αTLM = 0.77, αEMS = 0.89, αLCL = 0.90) as shown on Table 1. Additionally, composite reliability indicators were satisfactory and above the 0.7 stipulated threshold (CR ≤ 0.83). Table 1 shows the values of composite reliability where LCL demonstrated a higher value of 0.96 while MOT revealed 0.83 albeit above the accepted threshold of 0.7. Subsequently, the square root of the AVEs was compared for the confirmation of discriminant validity which was expected to exceed the correlations between constructs and any other construct (Fornell & Larcker, 1981). To ascertain the strength of the model by way of the relationships between the various variables, we adopted a two-way correlation approach: the observed correlation and the reproduced correlation and communalities with residuals. From Tables 1 and 2, 8(29%) of the residuals shows values above 0.05, therefore, demonstrating goodness of fit. Importantly, both measures demonstrated good model fit and, also, did not show much residuals thus allowing the authors to proceed with other measurement methods.

We provide detailed information on the mean scores as well as the standard deviation on Table 1 where MOT (M = 4.45, SD = 0.42) showed higher mean values as compared to the least mean values demonstrated by TLM (M = 3.94, SD = 0.74).

Table 1 provides detailed information on the strength of association between the eight variables. A statistically significant relationship was shown between CKE and EMS (r = 0.77, p < 0.01). The correlation, therefore, suggests that adult learners who considered their core knowledge in engineering as relevant in explaining their conceptions of learning also regarded employability skills as necessary in the learning process. This, however, explains only 59.3% (R² = 0.59) of the variance. The study also showed a significant relationship between EMS and LCL (r = 0.79, p < 0.01), thus, demonstrating that 62.4% (R² = 0.62) of the variance in adult learners’ appreciation of their
priorities could be explained by the employability skills they derive from their programme. Importantly, the other variables (PRA, MOT, TEC, COJ and TLM) all demonstrated positive statistically significant relationships as shown on Table 1.

The next step we adopted was to test for the suitability of the data for factorisation and the existence of patterned relationships. We proceeded to compute the Bartlett test of sphericity, which provided information on the correlation between the eight variables and this also showed a strong statistical significance ($p < 0.01$). Additionally, we adopted the Kaizer–Mayer–Olkin measure of sampling adequacy (MSA), which also sought to correlate the pairs of the variables and the magnitude of partial correlations among the eight variables developed. Importantly, the MSA revealed a meritorious value of 0.831, which also propose that the correlations between the eight variables can be explicated by the other variables in the dataset. We followed this method particularly to ensure that the pairs of variables that provided information on the learning conceptions of adult learners were statistically significant at an overall measure of 0.6.

6.1.2. Factor extraction and rotation

To arrive at theoretically similar and significant groups of issues regarding the variables that provide explanation to adult learners’ conceptions of learning higher education, PCA by way of direct oblimin rotation and Kaiser normalisation (often referred to as the Kaiser criterion) was performed. Importantly, eigenvalues equal to or greater than 1.00 served as the basis for determining the number of factors to use. With respect to the variables used, oblimin rotation demonstrated eight factors, showing 33, 8, 6, 5, 5, 4, and 3% of the total variance (see Table 2).

However, 77.78% of the total variance was accounted for by the oblimin rotation that was provided in 23 iterations (see Table 2) with factor loadings. Additionally, to enhance the interpretability of the eight factors derived from the computation, only variables with the factor loadings greater than 0.5 were included in the table. It is important to note that, the non-orthogonal factor rotation by way of direct oblimin (oblique) method provides significant grouping based on theoretical underpinning that also sought to explicate the various factors that influence adult learners’ conceptions of learning. The items within the various factors (CKE, PRA, MOT, COJ, TEC, TLM, EMS and LCL) showed strong correlation with the coefficients above 0.5. Importantly, the oblique rotation method does not limit researchers to observe 90° angle between the various factors during rotation and this allowed the different factors to correlate during rotation.

### Table 1. Correlation Matrix with Mean, SD, CA, AVE and CR

|       | M     | SD    | CA (α) | AVE   | CR    | 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8  |
|-------|-------|-------|--------|-------|-------|----|----|----|----|----|----|----|----|
| CKE   | 4.343 | .505  | 0.855  | 0.616 | 0.886 | .785|
| PRA   | 4.307 | .509  | 0.847  | 0.528 | 0.845 | .489|
| MOT   | 4.449 | .421  | 0.802  | 0.502 | 0.828 | .519|
| TEC   | 4.138 | .564  | 0.823  | 0.564 | 0.865 | .706|
| COJ   | 4.117 | .565  | 0.791  | 0.527 | 0.844 | .525|
| TLM   | 3.936 | .738  | 0.772  | 0.622 | 0.889 | .565|
| EMS   | 4.289 | .522  | 0.891  | 0.937 | .772  | .717|
| LCL   | 4.203 | .544  | 0.904  | 0.836 | 0.962 | .601|

Correlations are significant at the $p < 0.01$ level. The square roots of the AVEs are displayed on the diagonal in bold fonts.

CA—Cronbach Alpha
AVE—Average Variance Extract
CR—Composite Reliability
M—Mean
SD—Standard Deviation

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Table 2. Loadings for the rotated components

| Descriptive | Items | Components |
|-------------|-------|------------|
|             |       | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| Comprehension of technical course requirement | CKE1 | .631 |   |   |   |   |   |   |
| Comprehension of theories and concepts | CKE2 | .640 |   |   |   |   |   |   |
| Adaptation to skills requirements in class and on field | CKE3 | .716 |   |   |   |   |   |   |
| Relate theories to job setting | CKE4 | .954 |   |   |   |   |   |   |
| Programme relates to job-skills needs | CKE5 | .922 |   |   |   |   |   |   |
| Programme enhances creativity | PRA1 | .732 |   |   |   |   |   |   |
| Programme is enriched with advanced technology | PRA2 | .882 |   |   |   |   |   |   |
| Programme promotes work ethics and discipline | PRA3 | .798 |   |   |   |   |   |   |
| Programme enhances critical thinking and problem solution | PRA4 | .607 |   |   |   |   |   |   |
| Programme is enriched with complex mathematical analysis | PRA5 | .775 |   |   |   |   |   |   |
| Motivation to work in teams and independently | MOT1 | .667 |   |   |   |   |   |   |
| Enthusiasm to comprehend advanced engineering processes | MOT2 | .500 |   |   |   |   |   |   |
| Motivation to be professionally disciplined and result oriented | MOT3 | .604 |   |   |   |   |   |   |
| Motivation to share knowledge and solve problems in teams | MOT4 | .748 |   |   |   |   |   |   |
| Motivation to learn and use modern engineering technology | MOT5 | .945 |   |   |   |   |   |   |
| Ability to apply technology in the laboratory | TEC1 | .695 |   |   |   |   |   |   |
| Relationship between programme and technology application | TEC2 | .884 |   |   |   |   |   |   |
| Technology promotes effective learning and work performance | TEC3 | .755 |   |   |   |   |   |   |
| Technology application simplifies work processes on the field | TEC4 | .646 |   |   |   |   |   |   |
| Technology enhances knowledge acquisition in engineering | TEC5 | .755 |   |   |   |   |   |   |
| Relate course work to specific job requirements and roles | COJ1 | .759 |   |   |   |   |   |   |
| Relate peer interaction in lecture room to job skills needs | COJ2 | .796 |   |   |   |   |   |   |
| Ability to match learning outcomes to skills needs | COJ3 | .546 |   |   |   |   |   |   |
| Core course content relate to actual work processes | COJ4 | .588 |   |   |   |   |   |   |
| Practical sessions provide detailed information for job needs | COJ5 | .866 |   |   |   |   |   |   |
| Adaptation to teaching and learning methods used by facilitators | TLM1 | .825 |   |   |   |   |   |   |
| Ability to assess the teaching and learning processes used | TLM2 | .970 |   |   |   |   |   |   |

(Continued)
6.1.3. Evaluation of model fit
We observed the construct validity of the variables prior to testing the hypotheses to ensure that adult learners’ conceptions of learning actually support their knowledge and skills development and could as well be measured by SEM as stipulated by Hu and Bentler (1999). Relying on the results of the chi-square statistics and fit indices of RMSEA, CFI and TLI, we followed the rule of thumb for cut-off values when evaluating goodness of fit. According to Schermelleh-Engel et al (2003), an acceptable model of fit (SRMR ≤ .10, RMSEA ≤ .08, CFI ≥ .95) must be distinguished from a good model fit (SRMR ≤ .05, RMSEA ≤ .05, CFI ≥ .97). The fit indices derived from the computation actually supports the hypothesised eight-factor categorisation model of adult learners’ conceptions of learning in higher education; $\chi^2 = 8025.16$, df = 712; RMSEA = 0.02; CFI = 0.93 and TLI = 0.91.

6.2. Structural model
The structural model demonstrated good fit indices ($\chi^2$ (712) = 8025.16, $p < 0.05$; CFI = 0.974; TLI = 0.91) with three of the five hypothesised paths and three covariance significant and in the expected directions.
COJ had a negative significant effect in predicting LCL (H_{1b}; \beta = -0.02, p < 0.05) but correlated significantly to PRA (H_{3c}; \beta = 0.15, p < 0.05). The model also confirmed that PRA was significant in predicting MOT thus, providing support for hypothesis H_{3c} (H_{3c}; \beta = -0.10, p < 0.05). Importantly, TLM related significantly to LCL (H_{1c}; \beta = 0.20, p < 0.05) while TEC also related significantly to TLM (H_{2a}; \beta = 0.12, p < 0.05). CKE correlated significantly with PRA (H_{3b}; \beta = 0.11, p < 0.05). Although CKE had a negative significant effect in predicting TLM (H_{2b}; \beta = -0.01, p < 0.05) it did not relate significantly to LCL (H_{1a}; \beta = 0.17, ns). As shown on Table 3, EMS related significantly to TLM (H_{2c}; \beta = 2.79, p < 0.05). However, MOT did not relate significantly to TLM (H_{2d}; \beta = 0.05, ns).

The theoretical model by way of SEM established the predictive power of the variance explained (R^2) in the key endogenous constructs as 0.66—LCL. The results suggest that the theoretical model explains a greater part of the variance in the endogenous variable, LCL with an overall average R^2 of 0.66. Hair et al. (2014) recommend a good R^2 range of 0.50 >. The theoretical model, therefore, explains 66% of the variance in the learning conceptions of adults by way of a multiple-level categorisation approach which also reveals a high explanatory power. The result also suggests that 34% of the variance was not accounted for by the theoretical model and may be explained by other factors that were not shown in this study.

7. Discussion

Drawing from the results section, the authors show that the conceptions of learning among adults in higher education settings are influenced by two key factors: teaching and learning methods and the interplay between the core technical knowledge required for work and the skills. Contrastingly, adult learners’ core knowledge in engineering did not have any significant effect on their learning conceptions. The results revealed that practical application of the theories learnt and consistent feedback mechanisms are particularly important in the teaching and learning processes. What this means is that through hands-on application of the theories they learn and the incorporation of their experiences in the learning processes, adult learners develop their conceptions of learning which also shapes their knowledge and skills development. Significantly, the conceptions of adult learners in the learning process could be explained by the impact of the teaching and learning processes (Päuler-Kuppinger & Jucks, 2017) which is also underpinned by students approaches to learning (Prosser & Trigwell, 2017).

The constructivist theory as well as Andragogy (Knowles, 1996) espouse the importance of teaching and learning rules and procedures for constructing learning environments in a flexible way that allow adult learners cope with their work demand. Creating a flexible mode of teaching and learning for adult learners must provide relevant input in the development and actualisation of their learning activities (Sackney & Mergel, 2007) which also influences their learning conceptions. However, when

| Relationship | Hypothesis | C.R | Path Coefficients | P Value | Empirical Conclusions |
|--------------|------------|-----|-------------------|---------|-----------------------|
| CKE → LCL | H_{1a} | 1.35 | 0.01 | 0.173 | Not Supported |
| COJ → LCL | H_{1b} | −2.14 | −0.02 | 0.032* | Supported |
| TLM → LCL | H_{1c} | 3.26 | 0.20 | 0.001* | Supported |
| TEC → TLM | H_{2a} | 2.09 | 0.12 | 0.037* | Supported |
| CKE → TLM | H_{2b} | −0.24 | −0.01 | 0.023* | Supported |
| EMS → TLM | H_{2c} | 5.29 | 2.79 | 0.001* | Supported |
| MOT → TLM | H_{2d} | 1.23 | 0.05 | 0.220 | Not Supported |
| PRA ↔ MOT | H_{3a} | 3.85 | 0.10 | 0.001* | Supported |
| CKE ↔ PRA | H_{3b} | 3.08 | 0.11 | 0.001* | Supported |
| COJ ↔ PRA | H_{3c} | 3.84 | 0.15 | 0.001* | Supported |

* Significant at 5% for the two-tailed test. C.R.—Critical Ratio
the responses of adult learners to the teaching and learning experiences are negative, it eventually produces negative conceptions of learning.

Beyond the learning conceptions of adult learners, the study revealed that the priorities of adult learners in HEIs are essential for the knowledge and skills development of adult learners. Analysis of the survey data with respect to the priorities of adult learners showed that the teaching and learning methods are significantly influenced by technology-mediated environment as well as the ability of HEIs to develop the employability skills of adults. A positive relationship between teaching and learning methods and technology mediated learning, however, demonstrates timeless student-content and student-facilitator interaction that is relevant for continuous engagement and learning experiences. Furthermore, by way of practical field sessions, adult engineering students are able to get hands-on experience and opportunities to connect principles and theories (Case, 2008; Dickens & Alertt, 2009) learnt in class. When engineering adult learners do not develop their knowledge and skills through practical and laboratory activities, it affects their ability to transfer the theoretical knowledge to a problem setting in their field of work. Additionally, E-laboratories serve as useful sources of learning resources that provide practical experiences to learners through the use of digital modes and simulation (Dickens & Alertt, 2009). Importantly, the new technologies, laboratory activities and computer software identified by the respondents are essential in the development of their knowledge and skills which is also espoused by proponents of experiential learning (Case, 2008; Usher, 2009).

Practical field work also suggest a working relationship between HEIs and industry that involves continuous sharing of knowledge where industry could make use of the expertise and knowledge HEIs, while HEIs could also obtain funding for their research from industry (Santoro & Gopalakrishnan, 2000). Adult learners also obtain practical knowledge and skills through field trips and attachments, which are embedded in the teaching and learning methods. From the focus group discussion, the following were identified as necessary for the professional practice of adult learners; ethical, social and professional understanding, research and inquiry, information literacy, personal and intellectual autonomy and communication skills. One of the most important ways of developing employability skills is through internships. However, the absence of these skills could have adverse effect on the learning conceptions and priorities of adult learners in HEI settings.

The motivation of adult learners to obtain higher education qualifications and the interplay between the core technical knowledge required for work and the represent essential priorities of adult learners studying engineering programmes in HEIs. Frith et al. (2012) suggest that motivation for adults who enrol in higher education programmes are influenced by factors such as: prospects for personal growth; development of the knowledge and skills in a practical field of interest; obtaining academic qualifications; obtaining knowledge for societal contribution; enhancing ones chances of securing a job and securing promotion to steer clear of job loss. These factors together with the resources provided by HEIs could ultimately influence the priorities of adults who enrol in engineering programmes. Inversely, the study showed that teaching and learning methods are not influenced by adult learners’ motivation to obtain higher qualifications. The focus group respondents revealed that their motivation to enrolling in higher education programmes was to acquire further knowledge and the necessary qualification to meet the expectations of their employees.

Significantly, students’ approaches to learning provide a logical and systematic link between students’ learning conceptions, their views on the learning context, the quality of their learning outcomes (Prosper & Trigwell, 2017) and their learning priorities. Technical engineering knowledge and skills which could also be referred to as signature pedagogies (Shulman, 2005 cited in Hunt et al., 2013) are important for adult learners because they are expected to demonstrate certain competences after obtaining their certificates. The case-based approach and problem-based learning approach (Savery, 2006) in the teaching and learning processes in engineering could be enhanced only when the learning conceptions of adults are hinged on effective teaching and learning. Quinnan (1997) posits that supporting learners to develop critical reflection and developing dialogue within the learning environment are essential to the learning process of adults.
Summarily, the study revealed that the learning conceptions and priorities of adult learners involve the sharing of experiences and knowledge; second, that individuals enhance their learning conceptions through continuous engagement with programme content and interaction with facilitators by way social learning; and third, that adult learners motivation to acquire further knowledge and skills as well as certification also influence their conceptions of learning.

8. Conclusion
The authors show in this study that the conceptions of learning and priorities of adults are particularly necessary for developing their knowledge and skills as well as ensuring that they connect their learning needs with what they are taught in class. Importantly, teaching and learning methods as well as the interplay between adult learners’ core technical knowledge and skills required for work provide a strong framing for the conceptions of learning among adults in higher education. Factors such as motivation, programme relevance, technology and employability skills serve as essential priorities for adult learners to obtain relevant knowledge and skills for their personal and career growth. Although this study highlights the key ingredients that are necessary in conceptualising the learning conceptions and priorities of adults in HEIs while also revealing the knowledge and practical gaps, it was limited to adult learners in the telecommunications and electrical engineering fields only. Similar studies could, however, be carried out in other disciplines.

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Data availability statement
The data that support the findings of this study shall be available on request from the corresponding author [Yaw Owusu-Agyeman—yowusu-agyeman@gtuc.edu.gh]. The data are not publicly displayed due to restrictions based on ethical reasons.

Cover Image
Source: Yaw Owusu-Agyeman.

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Appendix

List of acronyms

| Acronym | Description |
|---------|-------------|
| CKE     | Core knowledge in engineering |
| PRA     | Programme relevance to adult learners |
| LCL     | Learning conceptions of adult learners |
| MOT     | Adult learners’ motivation |
| TEC     | Technology application |
| COJ     | Interplay between the core technical knowledge required for work |
| TLM     | Teaching and learning methods |
| EMS     | Employability skills |
