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The Impact of the Heterogeneity of Employees' Qualifications on Firm-level Innovation Evidence from Nigerian Firms

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1. Introduction

Employees' qualifications and skills are considered a prop to the performance of any organisations. Owing to the relevance of innovation to the growth of firms and even a country's economy, the essentiality of the quality of human capital has evolved. While the heterogeneity in knowledge inputs remains crucial to innovation, the proxied variable for most studies has been either employee with a high school certificate, graduate employees, or percentage of staff with a college degree. These prior studies do not show the heterogeneity in the employees' qualifications and how they individually impact the introduction of innovation. The only study that attempts this form of analysis is McGuirk et al. (2015). Even after highlighting the descriptive statistics with diploma/vocational certificate, bachelor, masters and PhD reported, the regression estimation only considers employees with bachelor certificates. Nonetheless, the traditional understanding of human capital theory often refers to the employees who are highly educated. Human capital theory pays significant attention to the investment in human capital and its economic benefit. Innovation literature usually measures human capital through the level of formal education, year of schooling (e.g. Cohen and Soto, 2007; Romer, 1990). The relevance of the quality of human capital to firm performance, especially innovative firms, is crucial (Mazzucato, 2013). Innovation is referred to as the most knowledge-intensive organisational process that relies on individual members and the collective knowledge of the firm (Adamides and Karacapilidis, 2006 & 2018). Also, the qualifications of the workforce could make it essential to integrate and contribute more to organisational performance. Various studies underscore the role of higher education institutions in the development of regions (see, Benneworth and Hospers 2007; Huggins and Johnson 2009; Carrillo, 2015; Kim et al., 2018). Studies have also shown the significance of the interplay between knowledge and innovation performance (Blind, 2012; Blind et al., 2017) at different levels including the firm, regional, and national level. This knowledge interplay is typically contingent on firm human capital's absorptive capacity. Human capital with a higher level of education has better ability to understand the knowledge flows from the international buyers, partners and competitors in the domestic or international market (Liu et al., 2017). Cohen and Levinthal (1989) argue that firms' internal R&D creates a pathway evolvement of new knowledge, further enhancing the firm's ability for exploiting and leveraging external knowledge. The ability of the firm to internalise external knowledge could be closely associated with its performance. While internal knowledge build-up could contribute greatly to a firm's ability to acquire and utilise external knowledge (Al-Laham, Tzabbar and Amburgey 2011), this paper contends that higher education attainment by the respective workforce could be essential in the knowledge accumulation process of a firm. This study focuses on the role of higher education qualifications in innovation performance in both manufacturing and services firms in Nigeria. Many corporate firms in developing countries like Nigeria are small & medium-sized that face innumerable challenges including inadequate human and financial capabilities; a debilitating state of infrastructure and hostile government policies which incapacitate the degree to which firms innovate. Notwithstanding all these challenges, the surviving firms are still making massive attempts in embarking on different innovative activities regardless of their narrow capability. One of the many challenges that these firms face relate to the quality of human capital. While there are several studies on knowledge-related issues in connection with innovation performance (Kim et al., 2018); and specific forms of qualifications and how they relate to innovation propensity, there is a paucity of literature linking different levels of employees' qualification and innovation performance. This, study, however explores this approach by investigating how diverse employees' qualifications within the purview of qualifications obtained in the Nigerian institutions of higher learning and how innovation at the firm-level is optimised.

1.2. Contextual Background

Nigeria's business environment has undergone numerous reforming programs since independence. The goal has been to make the country more business friendly to encourage private investments and innovation. Succeeding regimes have attempted to promote the development of science, technology and innovation. In line with this, the Science and Technology policy document has constantly been revised to include innovation and human capital development as a component (NBS-NESRG, 2018). The main goal of the policy document is to put Nigeria in middle-income status by 2020 through Science, technology and innovation. The Nigeria Shared Growth and Development Agenda, "Growing Beyond Numbers: Will Nigeria's Growth Be Inclusive in 2018 and Beyond?" also maps out more strategies to promote private sector competitiveness and innovation. Notwithstanding these efforts, firms still face significant obstacles that impede their capacity to innovate. The Nigerian business environment is largely dominated by small and medium scale enterprises (SMEs). Both SMEs and large firms have found it difficult to cope with political, economic and mostly security issues that have confronted the country for years. Given the size of these firms, that is, the SMEs, they are mostly unable to undertake formal in-service training for their workforce. This situation has hindered the development of the skills of employees and is believed to be one of the main constraining elements of innovation in Nigeria. R&D expenditure of firms has also not seen much improvement over the years. With limited government R&D subsidies, indigenous firms have not been engaged in much innovation. Much remains to be attained as Nigeria is currently floundering comparative to its human capital and does not seem to have a broad strategy for the science and technology sector. Low amounts of R&D financing and investment, lacklustre institutions, brain drain, and poor access to markets confirm Nigeria's S&T innovation potential. Nigeria's world competitive rating has nose-dived from 120 to 127 in the previous year. In R&D, Nigeria lags other countries that as South Africa and Egypt. Based on the NEPAD's African innovation Outlook (2010), Nigeria produced 27,743 papers or 12 per cent of the total research output of 19 African countries surveyed between 1990 and 2009 (NBS-NESGR, 2013).

Furthermore, quite several studies document the relevance of human capital as an essential candidate to spur firm-level innovativeness. The studies use several proxies as a measure of employees' qualification both at the firm-level (Cantner et al., 2015; Barasa et al., 2017); and country-level, respectively (see, Dakhli and De Clercq 2003; Rammer et al. 2009). This study examines the nexus between different tertiary qualifications and innovation performance. As far as this research is concerned, it is the first to address this relationship in a developing country context and contributing to the relevant and growing literature on human capital and innovation performance with a focus on tertiary qualifications: *Ph.D.*, *MSc*, *BSc*, *HND*¹, and *Diploma*², respectively. This study also emphasises the importance of formal training as shown by Cantner et al. (2014); van Uden et al. (2017); Flores and Melguizo (2018) which is instituted by the establishments to enhance workers' performance. We argue that formal training moderating the different tertiary qualifications should support a

¹ A Higher National Diploma (**HND**) is a job-related academic program provided by higher and further education colleges in Nigeria or the UK. While a full-time **HND** takes two years to complete, or three to four years part-time, in the UK, it takes four years to complete in Nigeria for full-time. The program is split into National Diploma and Higher National Diploma in Nigeria. The National Diploma (ND) takes two years after which the respective students may choose to go for a year internship program before returning to complete the 2nd half of the HND program. There are significant debates amongst academia in the polytechnics and university regarding the equalisation of the degree to a B.Sc. Generally, and theoretically, an **HND** is an equivalent to four years at a typical Nigerian university.

² It is a certificate job-related course offered by universities and polytechnics in Nigeria. It could be a year or two and does not exceed two years.

compelling firm-level innovation performance. Thus, the core questions we ask are 1. Does higher qualification contribute to firm-level innovativeness? 2. Does higher education qualification, moderated by training, support innovation performance? 3. Do internal R&D, and higher qualification provides an opportunity for firms to optimise innovation?

To shed light on this topic and offer in-depth answers to the questions raised above, the analysis is empirically examined using the Nigerian Innovation Survey for two waves, 2008 and 2011 of 1359 repeated observations of firms in the manufacturing and service sectors, respectively employing a bivariate probit estimation method. The evidence shows that PhD, B.Sc. and Diploma associate positively and significantly with the ability of the firms to introduce product innovation but negative and significant for MSc and HND. Diploma qualification instead results in a decline in process innovation. On the moderating estimations, there are mixed results regarding the blend of employees' qualifications, training and internal R&D. While a negative and significant effect of PhD & training is observed for product innovation, there is a positive and significant outcome for Diploma and training. A positive and significant result is obtained for BSc & training with process innovation. The paper does reveal a positive reinforcement effect for BSc and R&D; HND and R&D; Diploma and R&D for both product innovation. Based on this estimation, while the share of the highly educated workforce supports the introduction of product innovation, it does not, however, substantially increase the probability of firm-level innovativeness regarding process innovation. Although the blend of BSc and HND with R&D supports the propensity to introduce process innovation, it results in a decline with Diploma and R&D. A more nuanced picture is obtained for the joint probability from the marginal effect estimations. The implication of the results offers management some investment choices regarding the initiation of training for the workforce or the selectivity of the workforce for the R&D department.

The rest of the paper takes the following format. Section 2 reviews pertinent literature on the link between tertiary education qualifications, human capital, and innovation. Section 3 highlights the methodology, which includes data description, variable measurement, and model specification. Section 4 documents the presentation of the results and interpretation. Section 5 discusses the findings; provides some policy implications and presents areas for relevant future research.

2. Brief Literature and Hypotheses

From a theoretical point of view, this study considers that the degree of firm-level innovativeness is to a large extent dependent on the quality of the respective workforce. While general skills could be essential for the success of innovation, specific skills also play a pivotal role in the propensity of innovation within and across firms even in its narrower scope of applicability (Becker, 1993). The theoretical framework considers: first, the concept of innovation, what determines it, and the different types a firm undertakes; second, the human capital theory as an essential factor of firm-level innovation and last, theory underpinning the essentiality of the blend of the relevant knowledge inputs in the support of the successful introduction of innovation, which could include training and internal R&D.

2.1.1 Direct Effects of Higher Qualifications on Innovation Performance

Malerba (2002) indicates that knowledge remains an essential element in innovation and production. A knowledge-based economy literature also stress this relevance (see, Lundvall, 1993; Lundvall and Johnson, 1994; Cowan et al., 2000). Scholarly studies have also used different elements of the workforce knowledge diversity to measure firm-level innovation performance. Indeed, the effect of employees' qualification focusing on one degree such as high school certificate (see, Barasa et al., 2017; van Uden et al., 2017; Abdu and Jibir, 2018) has much been documented compared with the workforce diverse qualifications. According

to Nelson and Phelps (1996), a higher level of an educated workforce in a firm stimulates the capacity to comprehend, create and process information swiftly compared to those without education. Similarly, it has been argued that an all-encompassing basic education is a basis on which all adaptive innovative-related skills are built (Pro Inno, 2007: 35). The evolvement of economic activity in a knowledge economy highlights the relevance of knowledge or intellectual resources as pivotal production factors for the survival and success of any firms (Dean and Kretschmer, 2007). Scholars have also argued on the relevance of both knowledge-based and resource-based view of the firm for firm innovativeness. The resource-based view of the firm highlights human capital as a crucial resource to firm performance (Penrose,1959; Wernerfelt 1984, pp.171-180; Rumelt and Lamb, 1984, p556-570). Knowledge-based view of the firm, on the other hand, stresses the importance of absorptive capacity (Cohen and Levinthal 1989; Vinding 2007) to knowledge interplay. Both knowledge schools of thought stress the need for knowledge stocks and access as pivotal for innovativeness. We agree with studies that the interplay of firms’ intrinsic characteristics, resource endowment (Harrison, 2009; Gunday et al., 2011) and firms’ specific kinds of knowledge (Todtling, Lehner and Kaufmann 2009) could well project firms’ ability to grow and impact the economy. Figure 1 show a summary of the theoretical framework.

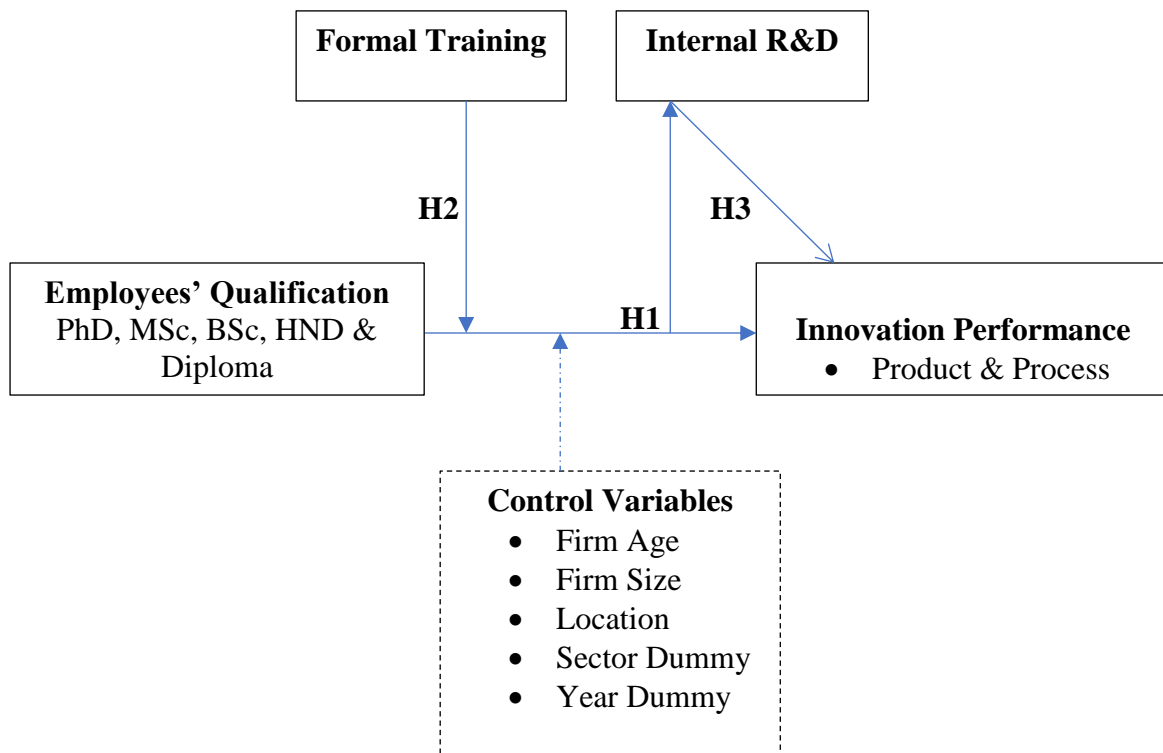


Figure 1: Theoretical Model and Hypotheses

A few studies use a percentage of the workforce with high school qualification to measure human capital about innovation performance (e.g., Barasa et al., 2017; van Uden et al., 2017; Abdu and Jibir, 2018), while others use a percentage of the workforce with a college degree (Roy et al., 2015; Cantner et al., 2014). However, the extant literature on the relationship between higher qualifications (with a focus on different degrees) and innovation performance is scarce. See, for example, Pfeiffer 1997; Oyelaran-Oyeyinka and Barclay 2004; Vinding 2007; Cabello-Medina et al. 2011; Acemoglu et al. 2014; Roy 2015; Oluwatobi et al. 2016; van Uden et al. 2017; Barasa et al. 2017. However, Castro et al. (2012)

argue that the innovation capability of a firm is contingent firmly on its intellectual and or organisational knowledge worth and its ability to take advantage of these assets for innovativeness. For knowledge complementarity, studies have also documented that alliance with other institutions and organisations could be an appropriate conduit to access external knowledge (Powell 1998; Bamford and Ernst 2002; Brusoni et al. 2001; de Man and Duyster 2005; Powell and Grodal 2005).

Also, some studies show the importance of basic research for technology, innovation, and economic growth (Tushman and Katz, 1980; Jaffe, 1989; Rosenberg and Nelson 1994; Mansfield 1995; Narin et al. 1997; Henderson et al. 1998; Cohen et al. 2002). It makes knowledge endowment a pivotal instrument for innovation performance. While others see knowledge as the driver of innovation performance, others see humans behind this interplay of knowledge. In the study of de Brito Cruz and de Mello (2006), highlighting boosting innovation performance in Brazil, they stress the importance of labour and its scarcity and further recommend that if innovation in Brazil were reckoned with, the widening gap in tertiary educational attainment would need to be bridged. Varsakelis (2006), on the other hand, shows in his findings that the higher the investment of a society in the quality of education, the higher the output of innovation activity. Also, Lopez-Nicolas and Merono-Cerdan (2011) argue further that strategic knowledge management could be vital for both innovation and organisational performance. Caniels and Bosch (2010) show in their study on the importance of higher education institutions in building regional innovation systems. The authors assert that higher education institutions serve as sources of academic knowledge and providers of academic education. Studies also show that there is an association between higher education institutions and development (Huijs 2003; Nieuwenhuis et al., 2003). Saad and Guermat (2014) in their study on national innovation and knowledge performance, stressing the role of higher education teaching and training, show that there should be a focus to increasing access to and investment in higher education, which they argue could be vital for innovation performance. The employees with higher education qualification could influence the performance of an innovative firm more propitiously in the following ways. Since the knowledge that some employees get while in secondary school could plummet swiftly in a dynamic environment (Bauernschster et al. (2009), we contend that having employees with higher education qualification, however, could support the implementation of complicated task and ideas for the firm. Also, while specific knowledge may be needed in some sections of the firm, having employees with higher education qualification other than a high school certificate could offer an advantage for the firm in investing less in formal training. Also, the idea that some potential employees do an internship during their formative academic days in the college, the kind of expertise required to carry out a task might be present in such staff with higher education qualification as compared to those with just a high school certificate. Further, Haltiwanger et al. (1999) assert that quality human capital affects the productivity of firms; notably higher education positively affects productivity.

Similarly, other studies stress that graduate employees are aiding influences for innovation activities (Leiponen, 2005; Haltiwanger et al., 1999). Also, Leiponen (2005) investigates the Finland manufacturing firms and finds that higher education or technical skills are the essential factors for successful innovation. Similarly, Vinding (2007) assesses 1544 manufacturing and service firms in Denmark and finds that the proportion of highly educated workforce correlates positively with the firms' propensity to innovate but relates negatively with the firms' ability to imitate innovatively. Saridakis et al. (2008) examine the role of human capital in small firms in England. The finding shows that the education of the business owners promotes the going-concerns of the firm. Although in the case of the German manufacturing firms examined by Schneider et al. (2010), it shows that highly qualified employees do not relate positively to the propensity of the firms to innovate. A

further counter-intuitive study of Blundell et al. (1999) reveal that highly-qualified and highly-skilled workforce cope swiftly and effectively to the novel task, and in essence promoting a direct channel for innovativeness. Hence, the first working hypothesis is formulated thus:

H1: Each higher education qualification of firms' workforce should uniquely, positively and significantly support firm-level innovation

2.1.2. The Moderating Role of Training in the Relationship between Heterogeneity of Higher Qualifications and Innovation.

The knowledge and adroitness of the employees achieved via training have aimed out to be essential with progressively more swift dynamics in technology, products, and systems. Most firms devote resources to workforce training because they trust that improved performance could be attained (Kozlowski et al., 2000). Nonetheless, the theoretical framework on the link between training and firm performance has been broadly contested. The focus of this study is formal training initiated by the firms to complement the baggage of individual workforce inherent knowledge and skills. Becker (1964) asserts that general training enhances the worth of trained workforce in any job and specific training is simply of significance to a particular manager or proprietor.

Formal training is indissolubly related to the degree of absorptive capacity in a firm (González et al., 2016; Lewandowska, 2015). SSA is embodied by a principally unskilled labour force (Lall et al., 2016; Tybout, 2000). In such a milieu, formal training performs a crucial role in imparting knowledge for developing employees skills (Blundell et al., 1999). Empirical studies show that formal training is superior for integrating new intramural and extramural knowledge that encourages both intra-organisational learning and inter-organisational learning (Leiponen, 2005; Tsinopoulos et al., 2018) for enhanced innovation performance (Dostie, 2017; Forés and Camisón, 2016; González et al., 2016; Laursen and Foss, 2003; Pfeffer, 1998; Sheehan, 2014; Vinding, 2006). Also, formal training relating to training programmes for the advancement or launch of new products is a human resource development activity that has far-reaching influences on innovation performance (Michaelis and Markham, 2017).

Formal training fundamentally underlies the skills element of innovation commercialisation and competitiveness (Chen & Huang, 2009). Skilled employees frolic an indispensable role in transmitting knowledge between firms; an embodiment of technology diffusion, technology investment and learning (Jones and Grimshaw, 2002). Firms, consequently, invest in an absorptive capacity (firm competencies) directly when workforces receive cutting-edge technical training (Cohen and Levinthal, 1990). Empirical studies examining different dimensions of formal training including managerial training and employee training report a positive association between training and innovation performance (Amara et al., 2008; Bryan, 2006; Dostie, 2017; González et al., 2016; Sheehan, 2014; Thornhill, 2006). Specifically, Amara et al. (2008) reveal in their findings that firms need a sufficient knowledge pool of skilful workforces to introduce both incremental and radical innovation.

Nevertheless, Whittaker et al. (2016) and Yáñez-Araque et al. (2017) unearth no connection between training and innovation performance in New Zealand and Spain, respectively. These authors contend that the nexus between training and innovation performance is more multifaceted than proposed by earlier studies. Also, in the perspective of West Africa, Robson and Obeng (2008) show that in Ghana, firms organising formal training had a greater probability of combating business impediments. In line with this, Egbetokun (2015) uncovers no significant correlation between formal training and innovation

performance in the Nigerian manufacturing industry. In contrast, Oyelaran-Oyeyinka & Lal (2006) establish that training is an elemental font of knowledge build-up that is positively related to innovation performance in Nigeria.

Human resource management (HRM) practices defined “as the focal process by which firms can impact and shape the skills, viewpoints and conduct of individuals” (Chen and Huang, 2009) are vital for fostering human resource capacities (Camps and Luna-Arocas, 2010). Additionally, HRM can amplify a managerial philosophy and framework that stimulate the ownership and diffusion of knowledge within the firm (Runar Edvardsson, 2008). Among the HRM routines, the central role of training for firms’ learning is underscored in some studies (Sanz-Valle and Jiménez-Jiménez, 2018; Seeck and Diehl, 2017) its impact on the growth of individual learning abilities, and its role in the development of a knowledge-related ethos. Overall, empirical studies exploring this relationship provide inconclusive evidence. Nevertheless, we contend that the initiation of formal training for the creation or introduction of new products could promote innovation performance and when moderated with employees’ diverse qualification could foster a better level of performance in the focal firms.

The studies so far linking formal training to the performance of the firms seem to have evolved with time. One cannot claim that the topic has been exhaustive. Studies show that most firms invest in training because they believe that such investment could enhance performance (Alliger et al., 1997; Kozlowski et al., 2000). The following studies have also documented the relationship between training and firm performance (e.g., Bishop, 1991; Black and Lynch, 1996; Bassi and Van Buren, 1998; Boon and van der Eijken, 1998; Fey et al., 2000; Faems et al., 2005; Tether, 2005; Zwick, 2006). The direct effect of training on innovation is not considered in this study, but only the direct effect of the different employees’ degrees (PhD., MSc., BSc., HND, and Diploma) on an innovation developed in the earlier paragraphs (see, Table 2). The reason stems from the fact that the relationship between training and innovation has much been documented to a large extent, but little is known regarding the association between the different employees’ qualifications and firm-level innovation outcomes. Except for the PhD and high school certificate that have been considered sparsely in previous studies (see, Mohammadi et al., 2017; Barasa et al., 2017; van Uden et al., 2017; Abdu, 2018; Basit and Medase, 2019). However, this section develops the argument for the relevance of training to innovation and its moderating role with employees’ qualifications in supporting successful innovation.

There are mixed results regarding the role of formal training in supporting firm-level innovation (Thang and Buyens, 2008; Thang et al., 2010). While some studies find positive evidence of an association between training and innovation, others have failed to observe any compelling evidence. While training refers to a program designed to provide recipients with the knowledge and skill needed on a job (Fitzgerald, 1992), a few individuals come to a job with complete knowledge and skills to perform on the job. Training initiated by firms could serve as an avenue to develop the workforce within the firm. Cohen and Levinthal (1989) argue that such initiated training increases the level of human capital in the firm as it fosters knowledge and capabilities apprise of the workforce. Training helps to decrease the intricacy of the problem to unravel and signal the goals of the establishments, which could foster creativity (Hirst, van Knippenberg & Zhou 2009), and perhaps enhance performance. As training could foster the application of new ideas within the firm and as well increase the knowledge base of the firm, it could signal that such a firm is open to new ideas. It means that firm that trains its workforce foster the execution of ideas because training could optimise the knowledge of the employees (van Uden, 2017), and perhaps increase the stock of knowledge for the firms (OECD, 2002). According to Bauernschster et al. (2009), creative

skills are essential for the evolution of radical ideas to support any firm performance. Hofheinz (2009) suggests that educational achievement is a useful measure of evaluating levels of skills in staff. Hence, one could surmise that training could be an enabler in complementing the skill of the workforce thereby fostering employees' productivity linking a designated task.

Further, higher skill is considered a tertiary accomplishment and medium skills as secondary education attainment. Arulampalam and Booth (1998); Wolbers (2005); Hofheinz (2009) find the prospect of training in supporting firm performance to be higher in all cases for the workforce with higher skills than for those with lower skills. Lundvall and Johnson (1994) argue that higher education supports innovativeness as graduate employees are more likely to invent and develop new technologies and that the higher educated workforce, the more likely that the employees will exploit technological progress. Developing an innovative human capital (IHC) where training and education are used as composition indicators, McGuirk et al. (2015) document that such innovative human capital composition supports the ability to innovate in small firms with employees less than 50 than larger-sized firms with employees more significant than 50. Egbetokun (2015); Egbetokun et al. (2017) stress the relevance of interactive learning and contend such as essential for capability buildup. The blend of the different firms' capabilities has been considered crucial for the implementation of innovation (Garcia-Torres and Hollanders, 2009). The relationship between a higher level of education and technical training is strong for organizational innovation (Toner, 2011). Education (being in the four walls of a classroom and taking courses) and training of any individual has been considered an investment in the human capital (Becker, 1993). Some authors also document the relevance of employee-skill level in innovation (see, e.g. Protogerou et al., 2017; Capozza and Divella, 2018; Bogers et al., 2018). While formal education is considered insufficient for the workforce to perform exceptionally in an establishment (Mincer, 1962), offering formal training to such workforce could serve as a complement to the already attained level of education, which could invariably support the knowledge build-up of the firms. The going concern of innovative firms is reported to have been supported by the institution of both formal and informal training (Baldwin and Johnson, 1996). Also, empirical findings show that firms that introduce product and process innovation by embedding training into the knowledge growth of their workforce are more probable than non-innovative firms to report output, employment and labour productivity growth (Danish Ministry of Business and Industry, 1996). Freel (2005) also shows a robust link between training intensity and the implementation of product and process innovation. Innovative firms have been reported to have pool of more educated employees than non-innovative firms and that dependence on the educational capabilities of their workforces supports the firms' profitability (Leiponen, 2005). Dostie (2017) reveal in an empirical study of Canadian firms that more training increases the likelihood of the introduction of more product and process innovation, with on-the-job training also contributing as much as formal structured training. Abogsesa and Kaushik (2017) also reveal training to boost the worker's job performance and productivity. Based on these premises, the second working hypothesis relates thus:

***H2:** Higher education qualification in combination with formal training reinforces each other's effects on the likelihood of innovation.*

2.1.3. The Moderating role of the Heterogeneity of Employees' Qualifications in the relationship between R&D and Innovation

According to Malerba (2002), firms are not necessarily the most suitable elements of analysis, but rather individual firms' sub-components, which may include but not limited to

R&D or production section. In the literature on innovation, studies have identified the essentiality of knowledge production in innovation systems, and more precisely, the role of R&D (Jasanoff, 1995; Salomon, 1997; Guston, 2000; Edquist, 2005). R&D is considered an essential index for firm-level innovation. The theoretical context for data collection on R&D defines this activity as ‘creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications’ (Frascati Manual, 6th edition, OECD 2002b). Also, it is often believed that R&D expenditures would lead to the creation of new knowledge and the effective dissemination of this knowledge could contribute to innovation. Investment in internal R&D not only creates innovation but it also allows the firm to identify, assimilate, and exploit the external knowledge from the environment (Cohen and Levinthal, 1989; Veugelers, 1997; Caloghirou et al., 2004). However, the ability to identify, assimilate and exploit external knowledge relies heavily on the quality of human capital. This paper contends that if a firm possesses a quality workforce, that is, with higher education qualification, the ability to grasp and internalise external knowledge could come with ease. Prior studies find that R&D intensity positively relates to innovation performance (Hurmelinna-Laukkanen et al., 2008; Mairesse and Mohnen, 2004). Similarly, Hall et al. (2009) posit that R&D intensity increases the likelihood of introducing both product and process innovation. Although previous studies contribute to the understanding of the link between R&D and innovation, the relationship between R&D and the different workforce qualification in supporting innovation at the firm-level is still elusive. However, Edquist (2005) documents that a well-educated workforce is essential for both R&D and innovation implementation. Considering that there are heterogeneous activities performed within R&D (Toner, 2011), the degree of variation in the employee’s qualifications could optimise the R&D activities of the innovative firms. Interestingly, the surveys of business R&D show that 46% of total people’s years in 2005-2006 involved in R&D in Australia are categorised as Technicians and other supporting. According to the OECD report, in the European Union, 44% of those engaged in business R&D in 2005 are categorised as Technicians and other supporting (OECD, 2006a). While both reports indicate that there seems to be a concentration in development instead of research, this current paper has the different qualifications moderating R&D and amongst the qualifications are those linked to technical support staff, e.g., HND and Diploma. In the study of Toner (2011), the author documents that there exists an inverse association between the share of research expenditure on basic research and the share of Technicians and other supporting occupation in the overall R&D staff. While citing an instance that around 5% of business R&D is devoted to basic research and 46% of this specific sector’s staff tend to skew towards the Technicians and other Supporting occupations. On the contrary, over 50% of the higher education sector’s R&D is categorised into basic research, and 17% of its staff consists of Technicians and other supporting occupations. Toner concludes that the technicians and other supporting staff are more involved specifically in incremental R&D that is geared mainly in the introduction of new products, services and production processes for commercialisation. Further, Kim (2002) shows empirically that more highly educated individuals tend to adopt innovations earlier and implement and adapt them sooner than less-educated individuals. The above review aligns with the objective of this current paper in that innovativeness could be optimised with the presence of highly-qualified workforce and blending that with R&D could provide further reinforcement for the introduction of any innovation. More importantly, the new growth theory underscores the relevance of qualified workforce as an essential input for the R&D segment where novel knowledge is produced and successfully introduced in the form of a new product or process (Barro and Sala-i-Martin, 2003; Cortright, 2001). Based on these considerations, the third working hypothesis is developed:

H3: Higher education qualification in combination with internal R&D reinforces each other's effects on the likelihood of innovation.

3. Methodology

3.1. Data

We use the Nigeria Innovation Survey Data that was collected with NEPAD³ support in conjunction with the Federal Ministry of Science & Technology and the National Centre for Technology Management. The survey covers Nigerian manufacturing and service sectors respectively. It is a pooled cross-sectional data collected over the periods 2005-2007 and 2008-2010. The dataset has a total of 1,359 observations. The Nigerian Innovation Surveys conforms to the Oslo Manual standard and agrees with most international standards. Note that Nigerian Innovation Surveys share the critical set of questions with the Community Innovation Surveys [CIS] of Europe. The sample was selected at random based on the list of establishments with at least ten (10) workers obtained from the National Bureau of Statistics (NBS) and the Nigerian Stock Exchange. The Stock Exchange list includes only formal firms whereas the NBS list includes both formal⁴ and informal⁵ firms. They cross-referenced the two sources and selected automatically any firms listed in both sources. It is worthy of recognition that the firms' exit rate is unusually high in Nigeria. Proportional probability is used to select the final sample. The survey questionnaire was distributed by hand to all the firms, and in many instances, some of the selected firms did no longer exist. In every possible case, the survey substituted the missing with another one in the same sector and geographic location. The survey was first carried out in 2008 (initial sample of 1,000 firms) and then repeated in 2011 (initial sample of 1,500 firms). The final pooled sample includes 1,359 firms (note that this number dropped in our estimations because some firms dropped out due to missing information on some essential variables), an overall response rate of 54%. The pooled cross-sectional dataset has some specific features: The dataset comprises data from wave 1 (2005-2007) and wave 2 (2008-2010) of the Nigerian innovation surveys. The year variable identified the different survey waves. Wave 1 of the survey was completed in 2008 and wave 2, in 2011. The survey is not a panel of the same firms (for details, see Egbetokun 2017).

3.2. Dependent Variable

3.3.1. Product and Process Innovation

This paper investigates the relationship between different employees' qualifications and innovation performance. The survey asks participating firms if they introduce new or significantly improved goods and services in the last three years for product innovation. Similarly, the survey asks respondents if firms introduce any innovative methods of manufacturing products or offering services, which represent process innovation. It takes "1" if the firm has introduced any of these innovation types and "0" otherwise.

³ The New Partnership for Africa's Development: it is a technical body of the African union saddled with the responsibility of enhancing Pan-African socio-economic development. it is a vision and policy framework for Africa

⁴ These are formal establishments employing 10 persons and above including professional services that employ less than 10 persons but highly formalized.

⁵ These are establishments owned by individual or businesses employing less than 10 or those businesses operating with little or no structures e.g. those in agriculture and wholesale and retail trade.

3.3. Independent Variable

3.3.1. Level of Education

We use different employees' qualifications as our explanatory variable. These include all employees with Ph.D., B.Sc., M.Sc., HND, and Diploma, respectively. The employees are in two categories: full-time and part-time employees. We combine part-time and full-time employees with the same degree as a measure of the independent variables. In this case, we aggregate full-time and part-time employees with a PhD degree in a single academic folder. This applies to MSc, BSc, HND, and Diploma.

3.3.2. Formal Training

Training refers to courses structured to help individuals develop skills that might be useful in their jobs (Blundell et al. 1999). Leiponen (2005) empirically reveals the importance of skills to innovation performance. This variable is unique to the economics of knowledge and one of the moderating variables with employees' qualifications. The survey asks top managers if the establishment provided formal training to employees. It takes "1" if the establishment does provide formal training to staff and "0" otherwise. Aside from managerial experience and workers' qualification, especial training (Smith, 2005) offered to staff by the establishment to stimulate innovation performance is considered a prerequisite for the firm's performance. We contend that interacting formal training with employees' level of education could exhibit a more positive return to firm overall innovation performance.

3.3.3. Internal R&D

Firms' R&D effort has been shown as one of the relevant variables that define innovative outcomes (Gomez et al. 2016). Also, R&D activities have been shown to have a positive relationship with firm growth (Hall and Hefferman, 1985; Coad et al. 2013). Studies have shown that firms that perform R&D record robust innovative outcomes than those that do not. Bogliacino et al. (2012) find an interesting result in R&D and employment growth. The survey asks top managers in the establishments if they do internal R&D. It takes a value of "1" if firms conduct internal R&D and "0" otherwise. The argument inferred by Cohen and Levinthal (1989); Brouwer and Kleinknecht (1996); Cassiman and Veugelers (2006) and Egbetokun and Savin (2014) on the importance of internal R&D to innovation performance suggests including the variable in our collection of explanatory variables.

3.4. Control Variables

3.4.1. Firm Age

Several studies have documented that age plays a role for the performance of firms (Huergo and Jaumandreu 2004; Jong and Vermeulen 2006; Huynh and Petrunia 2010; Coad et al. 2013; Yildiz et al. 2013) either to generate innovation (Anderson and Yoshihiro 2013) or to spur employment generation. However, these empirical studies have mixed results on the contribution of a firm's age to innovation performance. We measure it by subtracting the year firms began operation from the year-waves of the survey after which we express our outcome as a natural logarithm.

3.4.2. Firm Size: Full-time Employees

The firm size is measured as the natural logarithm of the total number of employees in 2010. Several studies use this measure, e.g., Bogliacino (2012 & 2014); Cantner et al. (2014); Mohammadi et al. (2017); Barasa et al. (2017). We use this measure as we argue that most

innovative firms' present and past employment figures provide researchers with the possibility of measuring firms' performance regarding innovations, and as a good measure of control.

3.4.3. Location

The firms are concentrated mainly in Lagos because of its commercial viability. It is also the second largest city in the country and serves as the headquarters of most of the establishments surveyed. In the context of Nigeria, we believe location, and especially city like Lagos, plays a prominent role in establishments' effort to generate innovation considering agglomeration effects and the concentration of human capital. Agglomeration has been one of the arguments put forward by scholars as contributing to firms' performance (Beule and Beveren 2012; Horbach and Janser 2016). Studies have shown both positive and negative association between agglomeration and innovation performance. For instance, Van Ort (2002) finds agglomeration as inconsequential to innovation intensity; only sectoral heterogeneity tends to explain the high degree of innovation. On the other hand, Ferreira et al. (2017) empirically find that the higher the geographic closeness of firms to urban areas, the more significant their capacity to innovate. In sub-Saharan Africa and Nigeria to be specific, this may play a role considering that agglomerated areas are likely to be more developed and infrastructure-concentrated as compared to less agglomerated regions. In the developed world, regarding the quality of infrastructure, there is likely to be less divergence. Thus, we measure location as a dummy variable, which takes "1" if a firm situates in Lagos and "0" otherwise.

3.4.4. Year dummy

We also assume that year plays a prominent role in the firm's innovative performance as this accounts for any microeconomic effects and external shocks. We measure a two-year effect based on the two waves of the survey by generating a dummy. It takes "1" if the year of the survey was 2008 and "0" if the year of the survey was 2011.

3.4.5. Sector dummy

In the survey, there are two sector classifications: manufacturing and services firms. Sector specificity also plays an important role in innovation performance being mindful of endogeneity and sector-specific differences in innovation output (Brouwer and Kleinknecht 1996). Considering the importance of the sector, and as argued by O'Sullivan (2006) that sectoral differences in innovative activity do have prominent implications in the allocation of resources. Also, Malerba (2002) indicates that sectors offer a pivotal stage of analysis for different schools of thought; either in business or academia in the investigation of innovative and production activities. We generate one sector dummy: manufacturing. It takes a value of "1" if a firm is in manufacturing and "0" if otherwise.

3.5. Econometric Set-up

The econometric specification reflects the interrelated steps in the innovative activities that arise from using a specific method, which is called process innovation to produce an outcome, product innovation. Hence, the study considers a lively correlation between product and process innovation. Owing to this, we utilize an independent equation framework by means of a bivariate probit model. We analyse our data by estimating a bivariate probit as a model fit, by running all the qualifications simultaneously to observe a relative share of each qualification on product and process innovation, respectively. The idea stems from the fact that both outcome variables are correlated. Our econometric approach is informed by the work of Cappellari and Jenkins (2003). All explanatory variables that define the

qualifications of the workforce are introduced simultaneously in the regression. Its basic latent variable illustration relates thus:

$$y^*_{ai} = \beta'_a x_{ai} + u_{ai} \quad (1)$$

Where $a= 1, 2$ (relating to product and process innovation equations, respectively), $i=1.....N$ (symbolising the i th of the focal firms), x_{ai} represents explanatory variables and β_a is an equation distinctive parameter vector. Instead of observing y^* directly, a binary variable $y_{ai} = 1$ if $y^*_{ai} > 0$, and $y_{ai} = 0$ otherwise is examined (see, Wooldridge, 2010). Essentially, innovation performance is observed when firms report to have introduced new or significantly improved forms of product and process innovation. While Equation 2 represents the individual estimation effect, Equations 3 & 4 represent the moderating effect of employees' qualifications with formal training, and internal R&D. The bivariate probit model specifies the outcomes as follows:

$$y_1 = \begin{cases} 1 & \text{if } y_1^* > 0 \\ 0 & \text{if } y_1^* \leq 0 \end{cases}$$

$$y_2 = \begin{cases} 1 & \text{if } y_2^* > 0 \\ 0 & \text{if } y_2^* \leq 0 \end{cases}$$

(Direct effect of Diversity of Employees' Qualifications): $Inno_i = \beta_0 + \beta_1 \text{Employee Qualifications} + \beta_2 \text{Firm Age}_i + \beta_3 \text{Firm Size}_i + \beta_4 \text{location}_i + \beta_5 \text{InternalR\&D} + \beta_6 \text{Training}_i + \beta_7 \text{Year Dummy} + \beta_8 \text{Sector Dummies} + \varepsilon_i$ (2)

Moderating Formal Training with Diversity of Employees' Qualifications): $Inno_i = \beta_0 + \beta_1 \text{Employee Qualifications} * \text{Training} + \beta_2 \text{Firm Age}_i + \beta_3 \text{Firm Size}_i + \beta_4 \text{location}_i + \beta_5 \text{InternalR\&D} + \beta_6 \text{Training}_i + \beta_7 \text{Employees Qualifications} + \beta_8 \text{Year Dummy} + \beta_9 \text{Sector Dummies} + \varepsilon_i$ (3)

(Moderrating Diversity of Employees' Qualifications with Internal R&D): $Inno_i = \beta_0 + \beta_1 \text{Internal R\&D} * \text{Employee Qualifications} + \beta_2 \text{Firm Age}_i + \beta_3 \text{Firm Size}_i + \beta_4 \text{location}_i + \beta_5 \text{InternalR\&D} + \beta_6 \text{Training}_i + \beta_7 \text{Employees Qualifications} + \beta_8 \text{Year Dummy} + \beta_9 \text{Sector Dummies} + \varepsilon_i$ (4)

4. Results

In the entire regression results, we observe a positive and significant correlation (ρ) for both dependent variables in the two equations indicating that the choice of a bivariate probit model is confirmed and supported instead of two separate probit models⁶. Table 1 reports the descriptive statistics and bivariate correlations of some selected variables. The full list of the descriptive and correlations variables is documented in Appendix A. While Table 2 reports the regression estimates in a seemingly unrelated framework using the bivariate probit model, Tables 3 on the other, reports the joint probability of both product and process innovation. Table 4 reports the robustness check analysis with a Tobit model using a percentage of sales of goods and services new to the firms as a dependent variable.

⁶ The estimations involving the individual effect of the independent variables are available but not reported in the paper. The estimations in seemingly unrelated framework are rather reported in the paper.

Based on Table 1, on average, Nigerian industries are quite intensive in innovation, as measured by the share of innovative firms, having a mean of 54% for product innovation and 53% for process innovation. Interestingly, the moderating variables; internal R&D and formal training have means of 52% and 79%, respectively. The means indicate that firms in Nigeria attach great relevance to both internal R&D and formal training for innovation.

We observe negative and insignificant correlations between *PhD* and both innovation types but a positive and significant correlation between *MSc*, *BSc*, *HND* and product innovation. Also, there is an observed positive and significant correlation between *HND* and process innovation. While we do not observe much variation amongst the staff with a *PhD* degree in the respective firms, significant variation is observed for other qualifications in this order *BSc*, *Diploma*, *HND* and *MSc*.

Table 1: Correlation and Descriptive Statistics of Selected Variables (N=919)

	Mean	S.D.	Min	Max	1	2	3	4	5	6	7	8	9
1. ProdInno	0.54	0.5	0	1	1								
2. ProcInno	0.53	0.5	0	1	0.492*	1							
3. PHD	0.76	11.52	0	270	-0.003	-0.019	1						
4. MSC	2.38	19.23	0	527	0.058*	0.025	0.673*	1					
5. BSC	9.29	65.19	0	1820	0.056*	0.014	0.035	0.481*	1				
6. HND	5.43	20.18	0	300	0.066*	0.059*	0.095*	0.248*	0.350*	1			
7. DIPLOMA	9.23	47.39	0	1246	0.039	0.014	0.133*	0.130*	0.161*	0.485*	1		
8. Internal RD	0.52	0.5	0	1	0.105*	0.171*	-0.000	0.012	-0.001	-0.003	-0.001	1	
9. Training	0.79	0.41	0	1	0.149*	0.217*	0.022	0.000	-0.017	0.058	0.036	0.311*	1

4.1. Direct Effect of Employees' Qualifications on Innovation Performance

Now, attention is shifted to the main analysis of the study. The study hypothesizes an association between the heterogeneity in employee's qualifications and innovation performance. The significance of the control variables is led by firm-level practices and innovation activity: *formal training* and internal R&D. These variables show a resonating consistent and robust effect on both product and process innovation in all the models in the respective regression tables. The results point to the essentiality of firm-level practices and innovative activity in supporting the propensity to innovate. The region in which the firm is located affects its innovative capability (Fitjar and Rodriguez-Pose, 2011). Similarly, the location may also affect the knowledge input (Sternberg and Arndt, 2001) and their interaction. The location factor plays a crucial role in the innovative capability of firms in this region of Africa. We also find in the results of location a significant correlation with both process and product innovation.

It is hypothesised in H1 that different employees' degrees should relate positively with innovation introduced by the respective firms. Table 2, Models 1&2, reports the direct effect of employees' qualifications on the product and process innovation, respectively. In Table 2, Models 1, we observe a positive and significant association between employees' qualification and product innovation in this order: PhD ($b=0.011, p<0.01$); BSC ($b=0.002, p<0.05$); and Diploma ($b=0.000, p<0.05$). On the contrary, MSc and HND return a negative and significant result thus: MSC ($b=-0.003, p<0.1$); HND ($b=-0.002, p<0.001$). On the contrary, in Table 2, Model 2 for process innovation, no significant coefficients are obtained for PhD, MSC, BSC and HND, respectively. However, a negative and significant outcome is obtained for employees with a diploma degree ($b=0.001, p<0.01$). Therefore, the working hypothesis testing the direct effect of employees' heterogeneous qualifications on the innovation

introduced by the firms is to a large extent supported for product innovation. An interesting observation in the coefficient estimates for product innovation and the qualifications relate accordingly to the highly-qualified personnel. The finding supports the study of Blundell (1999); Mohammadi et al. (2017). With Mohammadi, the heterogeneity of higher education measured by the share of the employees with a PhD positively correlates with incremental innovation. The education of the workforce, training and internal R&D are found to increase the probability of firms to innovate.

Table 2: Relationships between Employees' Heterogeneous Qualifications and Innovation Performance

VARIABLES	(Model 1) ProdInno	(Model 2) ProcInno	(Model 3) ProdInno	(Model 4) ProcInno	VARIABLES	(Model 5) ProdInno	(Model 6) ProcInno
PhD*Train			-0.300** (0.148)	-0.331 (0.287)	PhD*RD	-0.157 (0.410)	-0.003 (0.261)
MSc*Train			-0.010 (0.033)	0.041 (0.056)	MSc*RD	-0.063*** (0.009)	0.005 (0.003)
BSc*Train			-0.007 (0.015)	0.033*** (0.002)	BSc*RD	0.007*** (0.001)	0.003** (0.001)
HND*Train			-0.011 (0.015)	-0.046*** (0.006)	HND*RD	0.007*** (0.001)	0.019*** (0.004)
Diploma*Train			0.019*** (0.006)	0.002 (0.001)	Diploma*RD	0.009** (0.004)	-0.002*** (0.000)
PhD	0.011*** (0.001)	-0.006 (0.010)	0.311** (0.153)	0.306 (0.287)	PhD	0.203 (0.408)	-0.030 (0.259)
MSc	-0.003* (0.002)	0.002 (0.006)	0.007 (0.032)	-0.028 (0.056)	MSc	0.042*** (0.011)	0.012*** (0.002)
BSc	0.002** (0.001)	-0.000 (0.001)	0.009 (0.015)	-0.028*** (0.003)	BSc	-0.006*** (0.001)	-0.003*** (0.000)
HND	-0.002*** (0.001)	0.003 (0.003)	0.008 (0.013)	0.043*** (0.006)	HND	-0.003*** (0.001)	-0.004*** (0.001)
Diploma	0.000** (0.000)	-0.001*** (0.000)	-0.018*** (0.007)	-0.002** (0.001)	Diploma	-0.008** (0.004)	-0.000 (0.001)
Firm Age	-0.020 (0.059)	-0.043 (0.092)	-0.019 (0.055)	-0.039 (0.088)	Firm Age	-0.026 (0.066)	-0.037 (0.093)
Firm Size	-0.018 (0.015)	-0.008 (0.020)	-0.012 (0.017)	-0.017 (0.025)	Firm Size	-0.005 (0.020)	-0.010 (0.021)
Location	0.547*** (0.118)	-0.209 (0.171)	0.544*** (0.111)	-0.232 (0.171)	Location	0.543*** (0.108)	-0.236 (0.178)
Internal R&D	0.477*** (0.118)	0.612*** (0.077)	0.479*** (0.129)	0.577*** (0.089)	Internal R&D	0.425*** (0.124)	0.496*** (0.114)
Training	0.359*** (0.136)	0.511*** (0.180)	0.329* (0.176)	0.492* (0.252)	Training	0.381*** (0.130)	0.522*** (0.170)
Year Dummy	-0.249** (0.110)	0.257*** (0.036)	-0.251** (0.108)	0.296*** (0.045)	Year Dummy	-0.275*** (0.106)	0.298*** (0.032)
Manufacturing	0.267* (0.150)	0.642*** (0.059)	0.279* (0.146)	0.664*** (0.082)	Manufacturing	0.272* (0.150)	0.639*** (0.067)
Constant	0.080 (0.232)	-0.274 (0.347)	0.073 (0.212)	-0.250 (0.402)	Constant	0.072 (0.202)	-0.259 (0.375)
athrho	0.134*** (0.032)		0.129*** (0.040)		athrho	0.123*** (0.035)	
rho		0.133*** (0.032)		0.129*** (0.039)			0.122*** (0.035)
Observations	919	919	919	919	Observations	919	919

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

4.2. The Moderating effect of Training on the likelihood of the relationship between Employees' Qualification and Innovation Performance

In this study, it is hypothesized that employee's qualifications and formal training initiated by the firms should reinforce each other in supporting a compelling and successful innovation. Table 2, Models 3 & 4 reports the estimation results testing for H2. It is good to emphasize that when conducting moderation estimation, one of the moderating variables must be significant for the results to be valid. In this study, the moderating variable, *training*, shows positive and significant coefficient estimates in all the models. The role of the firm-level internal R&D also increases the propensity of firm innovativeness. This is observed to be positive and significant in all the models.

Now, attention is shifted to the moderation estimations. The results in Table 2 reveal that employees' qualifications' and training initiated by the firm negatively and significantly reinforce each other resulting in a decline to the firm-level introduction of product (PHD*train ($b=-0.300$, $p<0.01$); and process (HND*train: $b=-0.046$, $p<0.01$) innovation, respectively. The coefficients are also found to be positive and statistically significant for product innovation (Diploma*train: $b=0.019$, $p<0.01$); process innovation (BSc*train: $b=0.033$, $p<0.01$). Interestingly, diploma, BSC and training do reinforce each other in supporting the ability of the firm to introduce product and process innovation. The results indicate that there is a partial support for our H2 where we hypothesize that employee's qualification and training do reinforce each other to support the introduction of innovation positively. Nonetheless, the results obtained for product & process innovation indicate that training of employees in the upper ladder of qualification could be a disservice to the firms. Instead, the training of employees in the lower ladder of the qualification as we observe for employees with a diploma supports the ability of firms to introduce product innovation, and B.Sc. for process innovation.

The results rather inform us of a mixed relationship instead of a complementary outcome as proposed in our second working hypothesis. The results, however, do not obfuscate the understanding of the essentiality of training in complementing other knowledge-related input of the firms. The results only offer firms an investment decision regarding the training of their workforce. While the results reveal that employees in the lower ladder of higher qualification should be the beneficiaries of the initiated training, it also does inform the management on how to manage and distribute its resources as regards the selection of the workforce for any training activities.

4.3. The Moderating effect of Internal R&D on the likelihood of the relationship between Employees' Qualification and Innovation Performance

Furthermore, Table 2, Models 5 & 6 reports the interaction between the employees' qualifications and firm-level internal R&D. The working hypothesis tested here relates that the moderating role of employees' qualifications and internal R&D is a better candidate in supporting the ability of the firms to introduce both process and product innovation. Again, we first consider the relationship between the individual effects of the moderating variables and the dependent variables. Considering that internal R&D shows a positive and significant relationship with the dependent variable in all the models shows that the moderating coefficients are valid and reliable. Interestingly, training is observed to be positive and significant across the spectrum of the entire estimation. The reinforcement proposed in the third working hypothesis is supported by the results obtained in Table 2. As observed in Models 7 & 8, internal R&D and employees' qualifications reinforce each other. In this case, a complementary effect is observed in that the ability of the firms to introduce either product or process innovation could depend on the blend of employees' qualifications and internal R&D. It is interesting to note that the findings are observed for employees in the lower ladder

of higher education attainment. It indicates that BSc*RD; HND*RD; Diploma*R&D do support the probability of firms in implementing product and process innovation, respectively. The results of the coefficient estimates are observed in this order: product innovation, BSc*RD ($b=0.007$, $p<0.01$); HND*RD ($b=0.007$, $p<0.01$); Diploma*RD ($b=0.009$, $p<0.05$); process innovation, BSc*RD ($b=0.003$, $p<0.05$); HND*RD ($b=0.019$, $p<0.01$). On the contrary, a substitution effect is observed for MSc*R&D for product innovation ($b=-0.063$, $p<0.01$), and Diploma*RD for process innovation ($b=-0.002$, $p<0.01$). To a considerable extent, H3 is supported in the lower ladder of educational level and R&D. Importantly, in the joint probability estimates of product and process innovation, we observe a more nuanced picture of the relationship among the variables in the marginal effect estimations in Table 3.

Table 3: Marginal Effect of the Joint probability of Employees' Qualification and Innovation
Pr(productinnov=1, processinnov=1)-N=919

Variables	dydx	dydx		dydx
PhD*Train		-0.134** (0.037)	PhD*RD	-0.033 (0.029)
MSc*Train		0.031 (0.030)	MSc*RD	0.040** (0.012)
BSc*Train		0.091*** (0.046)	BSc*RD	0.026** (0.006)
HND*Train		-0.125*** (0.012)	HND*RD	0.040** (0.007)
Diploma*Train		0.067** (0.017)	Diploma*RD	0.019* (0.012)
PhD	0.001** (0.002)	0.139** (0.038)	PhD	0.037 (0.031)
MSc	-0.001 (0.009)	-0.027 (0.038)	MSc	0.058** (0.017)
BSc	0.005** (0.007)	-0.093*** (0.049)	BSc	-0.037** (0.007)
HND	0.003** (0.006)	0.130*** (0.010)	HND	-0.015** (0.003)
Diploma	-0.003* (0.001)	-0.076** (0.020)	Diploma	-0.033* (0.016)
Firm Age	-0.063 (0.144)	-0.060 (0.139)	Firm Age	-0.061 (0.149)
Firm Size	-0.046 (0.048)	-0.052 (0.063)	Firm Size	-0.027 (0.066)
Location	0.049** (0.037)	0.040** (0.042)	Location	0.044** (0.037)
Internal R&D	0.203** (0.016)	0.200** (0.023)	Internal R&D	0.168** (0.013)
Training	0.253** (0.087)	0.244*** (0.120)	Training	0.257** (0.079)
Year Dummy	0.004* (0.020)	0.013* (0.018)	Year Dummy	0.005** (0.019)
Manufacturing	0.221*** (0.037)	0.236*** (0.033)	Manufacturing	0.216*** (0.036)

Robust Standard Errors in Parentheses * $p<0.05$; ** $p<0.01$ *** $p<0.01$

4.4. Robustness Checks and Average Marginal Effects

We examine the robustness of our results by using a percentage of sales from the goods and services new to the firms as a dependent variable by way of a Tobit model. These results are presented in Table 4. We find that our results are robust to using this dependent variable. While Model 1 reports the individual effect of the qualification variables, Models 2 & 3 report the moderation estimations. The coefficients of the independent variables including training, internal R&D retain their sign and significance. Overall, the results are somewhat substantially similar. Consequently, our qualitative conclusions stay the same. Also, we

obtain the marginal effect estimates in supporting the raw coefficients estimates of the main regressions. This helps to simplify contrast and interpretation in a more concrete manner. Specifically, the average marginal effects mirror the influence of a one unit change in the independent variables on the predicted success likelihood of the corresponding outcome. This method averages all other covariates across the sample dispersion (see, for instance, Woodridge, 2010).

Table 4: % Sales of Goods & services New to Firms, Qualifications, R&D and Training

	(Model 1)		(Model 2)		(Model 3)	
PhD	0.0849***	(0.030)	-17.84	(26.020)	-3.045	(17.505)
MSc	-0.00285	(0.038)	0.574	(0.444)	0.762***	(0.100)
BSc	-0.0121**	(0.006)	-1.769**	(0.887)	-0.184***	(0.024)
HND	0.116***	(0.036)	1.909***	(0.423)	-0.0509	(0.031)
Diploma	-0.0241***	(0.008)	-0.0811	(0.162)	-0.00507	(0.101)
Firm Age	-4.800***	(0.965)	-4.726***	(0.837)	-4.828***	(1.102)
Firm Size	-0.738	(1.781)	-0.907	(1.817)	-0.709	(1.644)
Location	-3.377	(3.312)	-3.675	(3.503)	-3.486	(3.366)
Internal R&D	8.065***	(2.862)	8.078***	(2.843)	7.284***	(2.771)
Formal Training	13.26***	(4.611)	12.33***	(4.364)	13.36***	(4.391)
Year Dummy	-1.005	(2.277)	-1.083	(2.337)	-1.086	(2.207)
Manufacturing	5.149	(4.141)	4.842	(4.321)	5.227	(4.074)
PhD*Train			17.82	(26.141)		
MSc*Train			-0.512	(0.382)		
BSc*Train			1.777**	(0.883)		
HND*Train			-1.841***	(0.402)		
Diploma*Train			0.0641	(0.155)		
PhD*RD					3.178	(17.363)
MSc*RD					-0.793***	(0.084)
BSc*RD					0.185***	(0.027)
HND*RD					0.196***	(0.030)
Diploma*RD					-0.0303	(0.097)
Constant	-0.668	(10.834)	1.270	(10.383)	-0.234	(10.465)
Sigma	42.20***	(6.205)	41.95***	(6.317)	42.14***	(6.243)
Observations	919		919		919	

Standard errors in parentheses * p<0.10** p<0.05 *** p<0.01

5. Discussion and Conclusions

This work is inspired by the desire to inform the innovation activity of firms that pursue both product and process innovation in Nigeria. We are specifically interested in understanding how employees' different degrees shape the innovative capability of firms. Prior studies focus mostly on the percentage of graduate employees (Cantner et al. 2017); workforce with high school certificate (Barasa et al. 2017; van Uden et al. 2017), year of schooling and specifically share of employees with a PhD degree (Mohammadi et al. 2017). This study, however, extends the existing literature by considering the different degrees obtained by the workforce using PhD, MSC, BSC, HND and Diploma, respectively. The study does not only reveal the relevance of the quality of human capital to the propensity to innovate, but it also shows how the blend of training and R&D with these qualifications further reinforce the extent to which firms innovate. Although the results tend to reveal a much diverged results that should be interpreted with much caveat; it does not mean that the results do not reveal some potential practical implication for top managers and the human resource team of the focal firms. The working hypotheses of this study are built on the view that heterogeneity of employees' qualifications should serve as an enabler for performance and potential reinforcers when blended with other knowledge-related inputs.

To the specific and direct relationships between employees' qualifications and the propensity to innovate by the firms, this study finds that firm's ability to innovate in Nigeria, especially for product innovative-firms, relates positively with the highly educated workforce. The employees with a PhD, bachelor and diploma's degrees tend to impact the innovativeness of an establishment. Because firms operate in broad, diverse markets, fostering competitive advantage both in the local and global markets is essential with employees with various qualifications. It is practically unfeasible to have a locked-in catalogue of competencies that firms may need. The heterogeneity of firms' capabilities inherent in their employees remains even more apparent noting that innovation is not solely linked to commercialization alone but offering a specific new panacea to complex socio-economic issues. For developing countries, especially Nigeria to catch up innovatively and technologically, the idea of competence and competence building, inherent in both formal schooling and initiated training, is increasingly relevant (Fagerberg and Srholec, 2009).

The increasing relevance of investment in formal education has been adjudged to contribute significantly to innovation at the three levels of educational attainment: primary, secondary and tertiary (Varsakelis, 2006). Not only that education attainment by the respective workforce fosters performance regarding the propensity to innovate; it further allows the workforce to essentially develop soft skills that may be required by the firms, which include communication and interpersonal competence (Borras and Edquist, 2015). According to Davies et al. (2011), the soft skills include but not limited to the following: communication, social intelligence, novel and adaptive thinking, competency, computational thinking, media literacy, trans-disciplinarity, new design mindset, cognitive load management and virtual collaboration). Further, Lam (2005) argue that acquiring softer skills is relevant because those skills could help complement the 'hard' skills which spur employee's creativity and reveal better ways of dealing with organisational problems. This study, however, reveals the relevance of employees' heterogeneous educational qualifications to the firm performance. It further shows that both employees in the upper and lower ladder of higher education attainment can support the success of the firms regarding innovation, especially product innovation. While this analysis offers new insights into the contribution of human capital to the innovative capacity of the firms, prior studies like McGuirk et al. (2015) find no significant effect of the higher levels of education on product, process and service innovation. Schneider et al. (2010) using the German microdata find an insignificant relationship between educated employees and the likelihood of being innovative-active firms. Henny and Albaladejo (2002) find that higher tertiary education contributes to the innovative abilities of the firms in small electronics and software in the southeast of England.

Furthermore, while employees with higher education have been confirmed to support innovation, employee's educational attainment has also been considered as not enough to support the innovative capabilities of the firms. Hence, there is a need for competence building, which Borras and Edquist (2015) refer to as a continuum, bordering on the initiation of on-the-job training to complement the respective educational qualifications of the workforce. As a result, this study proposes the relevance of blending employees' higher education qualifications with formal training as a means of increasing the absorptive capacity of the employees and contributing to the firm-level innovation amongst firms in Nigeria. While the findings support the second working hypothesis marginally, it is observed that by blending employees' qualifications with formal training results in a decline to the ability of the firm to introduce product innovation with some specific workforce. These results show that management could better prioritize their investment in the workforce amid a challenging economic situation and scarce resources in developing countries; in that those with a higher level of education may not necessarily require massive investment regarding training, except those in the lower ladder of the academic qualifications. This could be a revelation to the

firms in that vocational or technical training is essential for workers with lower educational attainment, e.g., diploma, as compared to those with higher education qualification. The results do not support the argument of Toner (2011) regarding the blend of higher levels of education with training in promoting innovation. While we exercise some caveats in the interpretation of these results, the results could vary when small and large firms are considered separately of which this study does not employ. So, the results show that having employees with heterogeneous disciplinary backgrounds, regarding higher education degrees, the ability to innovate could be enhanced.

Also, this study proposes that the blend of employees' qualification with the internal R&D of the firm could serve as a potential candidate in supporting the ability of the firms to innovate. Fascinating results emerge regarding the significance of the blend of this inimitable and essential knowledge input. Higher education attainment with R&D relates positively and significantly in the introduction of both product and process innovation. This outcome could be rationalized by other findings on the relevance of both the role of educational attainment and firm-level formal internal R&D and the success of innovation. The third hypothesis (H3) is confirmed mostly for employees in the lower ladder of academic attainment. The results show that the blend of employees' qualification, that is, *HND* and *Diploma* with R&D supports the tendency to which firms innovate. The results are not surprising for HND qualification because, in the Nigerian educational structure, those who graduate from the Polytechnic have more technical skills as compared to those with a bachelor's degree, a structure that seems to align with the configuration of the polytechnics in Germany. It suggests that administrative or managerial positioning could be a better fit for the workforces who are highly qualified. It further confirms the study on Toner (2011) that employees with technical skills relate positively to innovation and the performance of the firms in the R&D sector. The results further reveal that education and R&D are two activities essential for the performance of the firms and individual knowledge growth. Indeed, employees' formal schooling qualification and R&D have a fundamental significance in constantly discovering new knowledge and learning new skills to drive further innovative success. Therefore, this study shows that the optimization of innovation in developing countries requires educated personnel that could complement the R&D of the firms. According to the OECD report, more radical innovation to a large extent depends on the creation of basic knowledge through both education and science (OECD, 2007, p18). In a similar development, it has been confirmed that incremental innovation and perhaps the implementation of new technology previously in use in a different place is more essentially reliant on the skills and competence of the workforce (Solo, 1966; Amsden, 1989). In line with the OECD report, it is argued that a well-functioning and generally available education system facilitates the adoption and diffusion of innovation and that human capital is pivotal in the adoption of new technologies and the launch of innovative practices (OECD, 2007, p18). Importantly, this study has confirmed the relevance of firm performance to own-R&D and another indicator of the R&D pool that could be beneficial to the firms. Based on the percentage of firms that conduct internal R&D in the sample data, it increasingly confirms that firms in Nigeria see R&D as one of the innovative activities that could constantly support the ability of the firms to innovate owing to the relevance of the integration of external knowledge to complement firms' performance.

5.1. Theoretical Implications

This study contributes to two essential streams of literature. First, it adds to the literature on the significance of the human capital to the performance of the innovative-active firms, and this occurs in the following ways. While previous studies focus on the percentage of the workforce with a high school certificate, college degree, and other managerial competence, very few studies have examined how the individual human capital higher education qualifications could support the propensity to which firms innovate. This article provides

evidence on the individual impact of the workforce qualification on the introduction of innovation. It is revealed that employees with a PhD, BSc and diploma degree correlate with the ability to introduce product innovation. The study also corroborates the findings from prior studies on the relevance of a highly-qualified workforce to performance (Blundell, 1999; Leiponen, 2005; Toner, 2011; Mohammadi et al. 2017).

Second, the study also contributes to the streams of literature on the complementarity of innovative inputs to the success of innovation, that is, the role of distinct knowledge types on the innovative performance of the firms. Prior studies use aggregated educational level (McGuirk, 2015) or focusing on the lower level of education either as a measure of human capital educational endowment or as a moderating impact (see, Barasa et al. 2017; van Uden et al. 2017; Abdu and Jibr, 2018). In this current study, by examining two dimensions of moderation impacts: fragmented employees' degrees with training and R&D, the study provides further evidence on the relevance of the combination of different knowledge inputs to innovation performance. The study shows that firm-level practices such as training, and firm-level innovative activity, such as R&D are essential for innovativeness. With some selectivity, this article indicates that individual competence complements firm-level competence building to impact positively on the innovative capacity of the firms. This competence building could allow firms to nurture and foster an open innovation strategy. This study, however, argues that training and firm-level internal R&D are fundamental to the stock of innovative knowledge.

5.2. Managerial Implications

This study has some essential managerial underpinnings in shaping the organizational investment in the workforce. If the findings of the study are aligned with the literature on the finance of innovation activities, one could assume that the level of managerial investment in employees' capacity and competence building could be optimal and selective. Optimal in a sense that, while employees with higher qualification might not require much training to integrate well into the objective and functioning of the organizational goal, the reverse could be the case for employees in the lower ladder of education qualification. Similarly, considering the inadequate of fund and resources at the disposal of most firms in developing countries, to manage the innovative activities, these results show that it could be beneficial to initiate competence building for employees in the lower ladder of education qualification instead of the highly qualified workforce. Raisch and Birkinshaw (2008); Mohammadi et al. (2017) have confirmed the relevance of ambidexterity as an essential determinant of organizational existence and success. The exploitation and exploration of activities within and outside of the firms are considered essential when firms have heterogeneous skilfulness in their workforce. This study shows that different workforce qualifications combined with firm-level practices are fundamental to the success of firms' innovative activities. The results are also relevant to the custodian of the education sector of the country. A potential policy actor is the Ministry of Education, Science and Technology in the country. The direction of the results, however, calls for investment in the quality of education in the country considering that different degrees awarded have perceived effect on the ability of the firms to innovate.

5.3. Limitations and Future Research

From a procedural point of view, this article has limitations that could be addressed in future research. While this article explores the entire highly-qualified workforce employed by the firms, the cross-section nature of the data makes it problematic to draw strong causal inferences or causality. So, this article could only establish correlations between the explanatory and explained variables. However, a possible availability of a panel data could empirically examine the direction of causality. Another potential limitation to this empirical paper is the inability to link the results of the different degrees as they relate to innovation

with prior studies. This, however, does not undermine the veracity of our empirical findings. Further, conscious of the concerns posed to data from developing countries, especially in sub-Saharan Africa, a tailored interview was conducted with the top managers of 22 establishments that are confirmed to be innovative in both manufacturing and service sectors, respectively. Since training and formal R&D are measured as dummy variables, they do not give a full account of the information on the variables. The tailored interview cum survey is to validate the choice of the moderating variables; firm *internal R&D* and *formal training* as a supplement to the existing data used in this study. The survey was conducted in Lagos, and from the outcome, 90.9% of the firms confirm to have introduced innovation of different forms in the last three years. Similarly, 86.4% of the innovations are new to the firms, and 59.1% are new to the market. 45.5% of the firms confirmed to have an R&D department with all the firms active in the four traditional types of innovation. Interestingly, all 22 firms establish to have initiated training as a competence and capacity building for their workforce. This supplementary survey, however, helps to strengthen the relevance of the moderating variable used in the study to mitigate the limitations that might be associated with the findings in this regard. This study provides an avenue for future research. To confirm the level of absorptive capacity of the firms, a moderating study of employees' distinct higher degrees with external R&D could be worthwhile. Also, a possible replication of the research for other countries due to different structures in the educational configurations to check for robustness and generalisation of the results is welcomed.

Appendix A

Table A1: Descriptive Statistics of Sampled Variables (N=919)

	Mean	S.D.	Min	Max
Product innovation	0.54	0.5	0	1
Process innovation	0.53	0.5	0	1
Full-time PhD staff	1.1	12.66	0	260
Full-time MSc staff	4.3	20.91	0	364
Full time BSc staff	17.36	90.09	0	1820
Full-time HND staff	9.88	23.46	0	300
Full-time diploma staff	15.64	42.53	0	500
Part-time PhD staff	0.84	9.68	0	150
Part-time MSc staff	0.81	11.8	0	257
Part-time BSc staff	1.79	12.76	0	150
Part-time HND staff	1.54	10.95	0	200
Part-time diploma staff	4.09	37.13	0	800
Firm Age	2.68	0.79	0.1	5.02
Firm Size	4.81	1.43	0	10.8
Location	0.41	0.49	0	1
Internal R&D	0.52	0.5	0	1
Formal training	0.79	0.41	0	1
Year Dummy (2011)	0.46	0.5	0	1
Manufacturing	0.65	0.48	0	1
Service	0.35	0.48	0	1
% of Sales Goods & Services new to firms	37.5	21.02	1	100

Table A2: Correlation Matrix of estimation Variables (N=919)

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	
1.Product innovation	1																			
2.Process innovation	0.492	1																		
3.Fulltime PhD staff	0.018	0.007	1																	
4.Fulltime MSc staff	0.072	0.026	0.611	1																
5.Fulltime BSc staff	0.068	0.02	0.011	0.658	1															
6.Fulltime HND staff	0.07	0.082	0.024	0.317	0.3	1														
7.Fulltime diplom staff	0.034	0.016	0.033	0.111	0.154	0.51	1													
8.Parttime PhD staff	-0.032	-0.077	0.337	0.334	0.056	0.079	0.171	1												
9.Parttime MSc staff	0.059	0.032	0.966	0.793	0.027	0.031	0.065	0.188	1											
10.Parttime BSc staff	0.049	0.005	0.063	0.091	0.429	0.173	0.124	0.313	0.187	1										
11.Parttime HND staff	0.056	0.045	0.043	0.123	0.237	0.309	0.156	0.229	0.147	0.714	1									
12.Parttime diplom staff	0.05	0.029	0.048	0.061	0.085	0.232	0.502	0.219	0.112	0.244	0.264	1								
13.Firm Age	0.042	0.001	0.009	0.016	0.002	0.087	0.035	0.002	0.035	-0.031	-0.021	-0.018	1							
14.Firm Size	0.078	0.089	0.024	0.209	0.266	0.429	0.411	0.052	0.044	0.146	0.123	0.146	0.336	1						
15.Location	0.115	-0.041	-0.029	0.029	0.025	0.131	-0.007	-0.036	-0.01	0.057	0.039	-0.016	-0.029	-0.012	1					
16.Internal R&D	0.105	0.171	0.056	0.065	0.068	0.136	0.112	0.001	0.09	0.092	0.102	0.087	-0.173	0.057	0.119	1				
17.Formal training	0.149	0.217	0.039	0.014	0.005	0.147	0.109	0.035	0.047	0.059	0.058	0.046	-0.093	0.057	0.048	0.311	1			
18.Manufacturing	0.017	0.139	-0.122	-0.114	-0.119	-0.024	0.008	-0.316	-0.039	-0.175	-0.14	-0.025	0.166	0.19	-0.294	-0.038	-0.055	1		
19.Service	-0.017	-0.139	0.122	0.114	0.119	0.024	-0.008	0.316	0.039	0.175	0.14	0.025	-0.166	-0.19	0.294	0.038	0.055	-1	1	

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