Economic Insights – Trends and Challenges	Vol.IX(LXXII) No. 2/2020	11 - 21

Innovative Educational Technologies for Early-Year Curriculum Delivery: A Theoretical Roadmap for Economies in Sub-Saharan Africa (SSA)

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Abstract

Technology is changing the way people do things in the world (Jackson, In Press1; Jackson, In Press; Lakshmi et al, 2020; Tchamyou, 2017) - there is a need to ensure early-year learners are availed the opportunity of embracing technology of some sort, in a bid to capacitate their scope for engagement in economically active operations in the world economy (Wallace and Wilson, 2020; Fletcher et al, 2020). The focus of this article, which was intended to initiate theoretical approach to exploring sound delivery of technology innovations for early-year learners' cognition is clearly demonstrated in the thematic diagram. In view of this, effort must be devoted by governments, particularly in the SSA region to invest resources in a bid to capacity human ingenuity. At the same time, collaborative partnership must be established with relevant stakeholders like parents and educational institutions (Schools and universities) to ensure the right level of provision is harnessed to capacitate opportunities for future society.

Keywords: *Innovation; Technological Roadmap; Early-Year Intervention; Sub-Saharan Africa (SSA).*

JEL Classification: *O32; O33; O38.*

Introduction: Objective and Emerging Knowledge

Technology is changing the way people do things in the world (Jackson, In Press1; Jackson, In Press; Lakshmi et al, 2020; Tchamyou, 2017) - there is a need to ensure early-year (notably 3-6yrs) learners are availed the opportunity of embracing technology of some sort, which will capacitate their scope for engagement in economically active operations in the world economy (Wallace and Wilson, 2020; Fletcher et al, 2020). The world population is at an increasing rate and far more so in developing economies, where the culture about childbearing is of utmost importance than economic factors (Mclsaac, 2020). Equally, opportunities harnessed through Research and Development (R&D) in technologies associated with Internet of Thing (IoT), image sensory and ultra-sound, have brought some level of confidence to confirm that risk to world health population (as witnessed with COVID-19) will continue to improve as time progresses (Wickramasinghe, 2020).

To harness the benefits of a rising global population as a form of future investment, effort should be made to capacitate early generation of learners so as to equip them on the challenges

that creative destruction (as catalysed in innovative technology and entrepreneurship) may bring to their future lives (Jackson, In Press). As the world takes a sophisticated turn towards technology innovation, notably Artificial Intelligence (AI) and Big Data (Bloom, 2020: Zwart, 2015), there is also high possibility of risks that lies ahead of society, more so to the younger generation about the need to become very versatile, at least in the usage of technology applications, while also demonstrating the ability for people to become highly innovative in their engagement with things that are likely to affect future direction of the world economy.

Despite advances made in forging ahead with innovative technologies to support educational development for early learning, there is still a long way to go in terms of its widespread applicability for economies in the global south, more so in SSA. On that note, the main aim of this paper is to develop a construct of theoretical review that will address the roadmap for exploring innovative technologies capable of serving as value-added to younger generations' access into future opportunities, for example job creation and enhanced creativity through Internet of Thing (IoT), Artificial Intelligence (AI) and many more (Jackson, In Press). In view of the cognition and passion of younger people's interests in technology, the emerging knowledge from the study will help carve theoretical discourses as a way of modelling what will constitute an appropriate technology to help younger generations become highly competitive in society, given the rapid rate of creative destruction in emerging technologies.

Rationale and Objectives for the Development of a Theoretical Roadmap in Early-Year Learning and Perceived Economic Benefits

In the current age of technology and also, the snail-pace development in Sub-Saharan Africa (SSA), there is a need to follow in the pathway of development that is capable of integrating children in early-year stage to become an integral part of the future generations of technocrats in technology innovation. Myriad of studies have attested to the fact that Africa needs to catch up with its counterpart in the Asian bloc, who in the not so far past were equally at a low pace of development (Rosati and Lyon, 2006; Ali, 2013). Many of these economies, notably Singapore and Malaysia adopted Import Substitution Industrialization (ISI) approach to create a means of instituting self-sufficiency by utilising rent-seeking opportunities availed through public funding (Jackson and Jabbie, forthcoming).

The world economy is in a state of fierce competition on account of advancement in technological innovations (Jackson, In Press1). While some economies in the SSA region are making use of scarce resources to capacitate means for enhancing human scope for development, others seem to be coasting (Jackson, 2017). In view of the way forward, children in the early-year stage should be highly prioritized as the future generation of technocrats and hence, emphasis on a theoretical roadmap for planning in advanced the pathway of technological development for the continent (SSA in particular) will help address current bottlenecks faced in terms of the backward delusive state of economies. On this note, the main objectives for this study are based on the undermentioned points:

- Produce a succinct narrative of technological innovations in view of early-year learning and their cognitive attributes.
- Produce an illustrative schematic roadmap, with narrative for innovative technological intervention in support of the future of SSA economies in particular.
- Highlight policy recommendations in support technology innovation in early-year cognitive development for the SSA region.

It is quite certain that effective investment in human ingenuity can bring about plethora of (economic) gains to society. In particular, there is hope that, with the growing population in the African continent as a whole, adequate utilization of human skills (notably early-year learners) will provide a solid ground for future flow of Foreign Direct Investments (FDI) into the

continent through capitalists approach in transforming globalization (Jackson, forthcoming1). To be more specific, it is envisaged that exposure of early-year learners to exploring innovative means of technology resources will steer the pace of their ingenuity towards being creative in different areas of innovative technologies, now seen to be utilised across the world. In addition, there is high scope that the availed opportunities will make it possible for equality of opportunities to be made an integral part of society's effort as children's creativity will be explored in totality, with greater access to job opportunities and the expansion of economies as the ultimate outcome for future generations (also linked to some of the Sustainable Development Goals agenda, notably SDG5, 8 and 9).

The Emergence of Technological Innovation for Early-Year Learning

Innovation technology is said to be influencing everything, particularly teaching and learning in the current information age; this can be attested across the spectrum of curriculum provision – from as early as in kindergarten to higher education in the global community (Jackson, 2015; Jackson, 2016; Jackson, In Press2). There is a wealth of knowledge that span across childhood development, which needs to be nurtured so as to make it possible for them to harness opportunities availed in the competitive world, more so in the utilization of skillset to face on-going creative destruction in human ingenuity (Jackson, In Press; Huffman, 2019). At gender level, emphasis should be devoted to embracing inclusivity – that which encourages both young male and female participation in utilizing talents connected with transformational competencies in technology innovation, now seen as the future direction for economic growth in the world economy (Jackson and Jackson, In Press3; Saffa and Jabbie, 2020).

Creativity in early-year learners can be harnessed through exposure to variety of opportunities, particularly that which is connected with access to modern technologies. The evermore buzzed words that have sought to captivate progress at all levels – innovation in the context of early-year learning is very essential in disrupting the status quo, in relation on how best to inspire change and development for present-day generation of young people and their future goals (Lesaux and Jones, 2018). In the context of early-year education and learning, it has brought a new form of challenge into the mind of adults to address possible ways through which the future of young people can be shaped, particularly in the direction of adapting to the dynamics of technological creativity.

In the context of this paper, the word innovation is presumed to be modelled along the line of two viewpoints – notably (1) the introduction of something new, and (2) changes that addresses new methods or approaches that foster the utilisation of technologies connected with Artificial Intelligence (AI), Internet of Thing (IoT) and many more for the advancement of human creativity (Lesaux and Jones, 2018). In the context of early-year learning, such approach could be achieved through varied mode of operations – for example, in the case of ensuring learners are able to engage practically in some form of activities that minimizes challenging behavioural attributes. Such operation goes beyond the art of adapting to new methodologies, but more in the direction of introducing variety of resources capable of supporting or captivating early-year learning styles that best suit learners' mode of concentration and participation, both in the context of independent and social domain of teaching and learning. Research endeavours have acknowledged the importance of early exposure of digital technology resources to children prior to their early-year entrance in school, which also shows that the approaches to teaching and learning should reflect children's early exposure to such facilities (Palaiologou, 2016; Hague, 2010).

Cognitive Attributes of Early-Year Learning

There is high prospect for investment in early year (normally expressed as between 0-6years) with regard to their state of cognition. Cognitive learning development as defined in Preschools4all (Online) is construed as the ability to think, solve problems, make decisions, and make sense of the world around us – such development can be divided into five categories, namely '*information processing, intelligence, reasoning, language development and memory* (Hijriyati, 2016)'. In this vein, cognitive skills is inclusive of the process of short and long term memory utilization, and as well as the reasoning, auditory, visual and speed of processing information. Children, particularly in the pre-schooling or early-year stage are thought to manifesting a form of self-centred view of the world, which means that they possess the power to learn and memorize concepts taught. This thereby makes it mandatory for their exposure to formal means of education (Amalia and Khoiriyati, 2018). In this regard, it is incumbent on the adult population, particularly public service authority (specifically department of education) and parents to make sure such innate characteristics of children are explored. In the given age of advancement in innovative technologies, children are more inclined to utilise their creativity by being exposed to variety of technology resources in a bid to tease their sense of future direction.

As expressed by Amalia and khoiriyati (2018), the most important thing for early-year learning is the utilisation of their cognitive power, which is in close concomitance with their brain and intelligence to make sense of things in and around their surroundings. Adults are very vital here to make sure they provide the right level of support for optimal utilization of early-year cognition so as to strengthen their future foundation. Higher level coordination and control of children's sensory system have made it very easy for them to express their prowess in creativity, which in most cases can be done through formal education and practical means of learning as in the case with experimentation of technology gadgets.

Despite evidence pointing to the fact that hereditary and the environment are most influential factors in a child's development (Khadijah, 2016), the most important of this is the coordination of both. Hereditary factor is based on genetic inherited characteristics from both parents, while environmental factor is what the child develop in their surrounding as they go through their lifecycle of development. Earlier studies by and Munsinger (1975) have shown that Intelligent Quotient (IQ) of children are the same as that of their parents, while the most important factor in the graduation of cognitive development is to make sure the environmental factor is highly favoured – the utilization of such factor (mainly attributed to formal learning and the home) can make it possible for children to learn and develop their state of cognition with things happening in their surroundings. This therefore makes it very much important for planning as highlighted in Figure 1 below to be highly incorporated so as to make it possible for coordinative efforts to be made an integral part of their developmental cycle.

While it is highly believed that the hereditary and environmental factors are essentially useful contributors to a child's cognitive development, Vygotsy, a Russian Psychologist laid emphasised on social factor, which can be gained through interaction with others (Danoebroto, 2015) - this is based on interpersonal interaction and socialization with people in the environment. The capability of children to be good social learners is quite a powerful process, which can be gained through exposure to a lot of resources, notably technological gadgets as seen more recently through their exposure to IT learning in schools. Equally, Piaget, a Switz Biologist also made profound effort to explore the importance of developmental and environmental factor in the process of early-year learning (Hildayani, 2009). Adults are also considered key players through the provision of resources and support in their developmental cycle.

Development of Theoretical Roadmap in Support of Early-Years Intervention in Technology Innovation – A Case of SSA Economies

Several scholarly works have been produced and are still on-going to address ways of adding value to human capital formation, particularly in early-year stage of development – such approach have been attested to be making tremendous impact on economic development, more so in developing economies, which so far have made strides in boosting their pace of economic growth (Attanasio, 2015; Hanushek and Woessmann, 2008; Hanushek and Kimko, 2000). More importantly, the relevance of cognitive skills as identified by Attanasio (2015: 950) cannot be over-emphasised, more so to do with investment that contributes to present and future pace of technological innovations. Apart from the prospect of economic growth gains, cognitive skills development, and particularly investments in the early-year learning have wider implications, which incorporate socio-emotional attributes and the innate drive and determination it brings into people's lives and as expounded in Pitt et al. (2012) study, the hope of bridging gap in the gender labour market.

More importantly concerned with the harnessing of skills development at the early-year level is the contribution of neuroscience as explained by Hackman et al. (2010), in understanding the association between socio-economic status and brain development (also cited in Attanasio, 2015: 951). In this regard, such theoretical postulation is attesting to the fact that the cognition of skills development should be addressed cohesively, with emphasis equally placed on socio-emotional and biological attributes, which overall needs the support of economic intervention. Given the malleability of children in their early years, it makes it very necessary for emphasis to be placed in developing a cohesive roadmap for society to rip the reward of long term innovative investment that will help children in SSA region to be highly competitive, when compared to their counterpart in regions around Europe, the USA an Asia. The emphasis on this is not necessarily done to exclude other age groups from the drive to nurture innovation, but the mere investment at this stage will make it very worthwhile for policies to be highly targeted at future needs of investment to support the pathway of economic development across the continent (Attanasio, 2015). This will also build capacity for enhanced Foreign Direct Investments (FDI) switch from Developed to the developing regions.

To this end, one will be very more inclined to postulate a heuristic approach, which is considered a worthwhile step in addressing the way forward on the roadmap for creative innovation in promoting technological capacity for future generations, particularly those in the developing world around Africa. Developing economies and particularly Sub-Saharan African (SSA) economies need to catch up with the rest of the world, and the best way forward is to ensure investment is focused at the early stage of life, specifically to children who are cognitively considered skilful thinkers. Children have innate ability to do things and also being moulded to fit a unique model of skills development pathway – this means that policies that drive the pace of early-year development capacity to harness relevant technology skills is considered relevant (Walker et al. 2011; Engle et al. 2011).

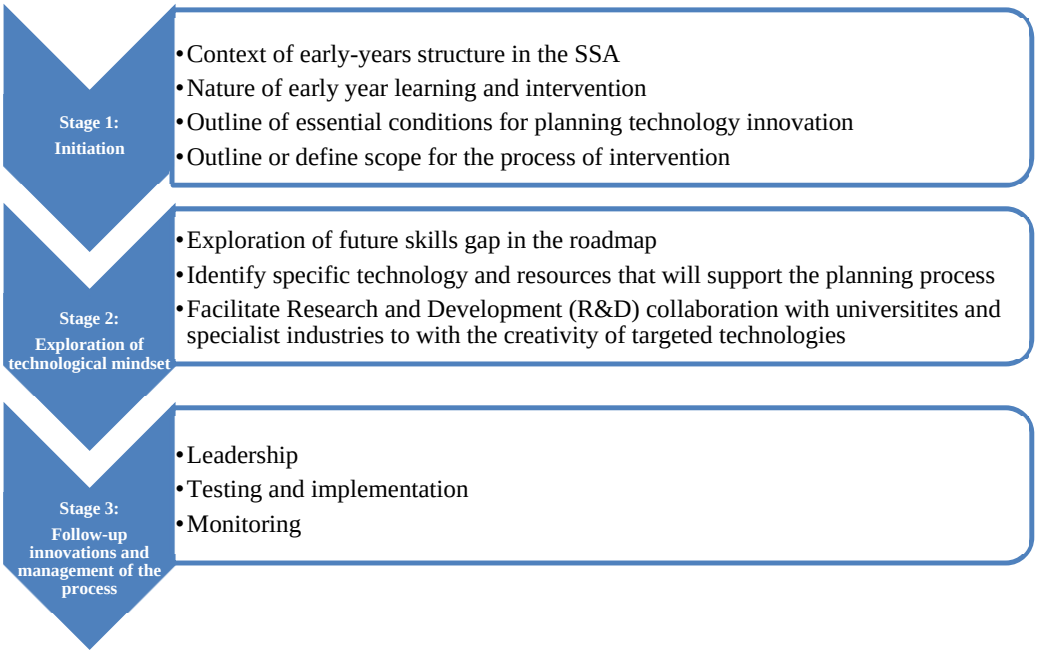

Fig. 1.: Technology Roadmap for Early-Years Intervention in Promoting Technology Innovation
Source: Author's Innovative Design

Figure 1 above typify a typical heuristic roadmap that can be utilised in supporting the pathway of projecting human creativity in technologies for nation building in the SSA region, with particular focus on early-year cognition. More specifically, the roadmap is viewed as a form of knowledge diagnosis in the management of ambiguous front-end creative innovations (Oliveira and Rozenfeld, 2010; Phaal et al, 2004). This can also be utilised as a first step approach in understanding the development of early-year structures in SSA economies – typically, the nature of poor economic system, which is manifested through low investment in education (Jackson, 2017) will help the roadmap to be very highly targeted in paving the way to capacitating future scope for nation building. It will also serve as a form of process utilised to support children's early development, given their malleability to cognitively adjust to circumstances in their formative cycle of educational pursuance, with the right level of support.

With reference to Stage 1 (Initiation), this is an opportune time for stakeholders (school administrators and the public service) to prepare ways of encouraging early year learners to be exposed to different means of technologies, capable of steering their attention to think creatively as future innovators. Given the importance of the public service, specifically the department of education as it is called in many countries, specialist knowledge of staff in the sector will be needed to help with the planning of logistics so as to make it possible for children in the early-year stage to explore their creative innovation mindset (Jackson, forthcoming).

Moving on, Stage two (Exploration of technological mindset) is geared towards planning the roadmap for early-year exploration of skillset. In this regard, it is therefore essential that resources are made available for children to be well exposed to myriad of technological resources, both in terms of their formal academic learning and also, that which will help them to become explorative thinkers, given the malleability of their cognitive ability to grasp concepts. Though costly the process may seem to be and also given the nature of scarce resource availability in SSA economies, there is a possibility that cooperation can be channelled between national educational bodies (namely, the Ministry of Education) and international organizations like the United Nations International Children's Education Fund (UNICEF) to help capacitate

means through which essential resources can be sourced to move ahead with the implementation of Stage 2. Equally, it is also vital that higher education institutions are also given the chance to become actively involved to train instructors or teachers in the early-year stage to acquire the right level of skillset needed to captivate the mindset of early-year learners. In this regard, there is a responsibility on the public service, notably the department of education to help build research capacity that will facilitate ingenuity in the area of transformative skillset (through support from professionals like educational psychologists, sociologists and product design professionals in the field of engineering) in the direction of supporting creative thinking for early-year learners.

Finally, Stage 3 (Follow-up innovation and management of the process) is very essential given the fact that a follow-up will be needed to ensure the process is made continuous, if the intention is to nurture future creative thinkers in the SSA region. Those assigned the task of managing the process will need to work collaboratively with professionals directly engaged in the early-year stage, while at the same time ensuring continuous research is explored to identify skills gap for children, which will be relevant to lead society in the next generation of becoming highly technologized, with capability of attracting FDIs in the sub-region. Invariably, there is the scope for creative-destruction process to be applied here given the need for future generations to be kept in pace with the rest of the world, particularly in terms of making SSA the future of global investments, where human transformative skillset will be at a level capable of attracting high investments from capitalists' intention to maximize profits through competitive utilization of factor productivity (Jackson, In Press; Jackson, In Press1). Professionals engaged at this stage will need to be vigilant in ensuring that technology resources are tested and regularly monitored in line with the capacity of early-year's utilization and their relevance, in a bid to enthuse their interests towards specific area of professionalism, requiring the use of technology intervention and creativity.

Exploring Markets for Early-Year Learning Innovative Technologies

Early-year learning is quite a specialist area of educational intervention – hence, the exploration of markets is of vital importance on the way forward in building a prospective society. The process of exploring markets for early-year learning innovations is hereby referred to as *disruptive technological* innovation, which Markides (2005) grouped into two main categories, namely "*Business Model and Radical*" disruption. The truth is that early-year as a specialist market, require relevant skillset of professionals to explore into the cognitive mindset of learners in a bid to captivate their interests and direction of future creativity.

The former of the two types of disruptive innovations (Business Model Innovation) is what Markides (1997) in an earlier research undertakings referred to as strategic innovations. In this, the mode of market intervention is based on attributes like price and speed of execution (Markides, 2005: 20). In order words, price may be utilised as the means of targeting customers, with varying success-factor to appeal to customers, who in this case are early-year learners. The business model of innovation should be capable of attracting new customers or expanding markets for early-year users to continuously challenge the pace of technological expansion. Likewise, attention should be focused in ensuring existing users are still made to utilise existing creative technologies, while at the same time, supporting the way for existing resources to be replaced in line with advances in technologies to challenge future means of exploring the world of unknown creative innovations.

As explained by Markides (2005: 20), utilization of the business model must be judged against set performance criteria, which will attest the competitive usefulness of existing and new technologies for early-year users, particularly in terms of meeting the requirement to challenging their pace of development. As emphasised by Christensen and Raynor (2003),

creative-destruction is a process which takes time, but eventually works with effective planning, through dedicated research effort to make sure society works in tandem with the pace of technological innovations that seem to be the domineering factor of firms' existence in the current age of technology. In this vein, there is a need to make sure the application of the technological roadmap as presented in Figure 1 is modelled with the right capability to support early-years' scope of utilising their ingenuity to become future creative thinkers in the SSA region, which at present is struggling to keep pace with the rest of the world.

In the case of radical disruptive innovation, the focus should be on '*new creation to the world of production*', which is needed to support and challenge early-year's ability to utilise their malleable state of cognition. In order to make the radical process a possibility, attention should be focused on '*supply-push*' (Markides and Geroski, 2005) capacity in ensuring the development of new technologies are done at a rapid state to address the needs of transforming early-year grasping of new technologies that are considered as value-added to their future life. The approach to radical disruptive innovation is modelled on continuous R&D, which is utilised by new entrants to introduce innovative product engineering to capture the mindset of early-year users. The main thrust of such a market-led process is to make sure the focus is to capacitate scope for engaging early-year learners to become the future of creative thinkers, who are capable of spearheading high pace of technological attraction for under-developed regions like the SSA.

Conclusion and Research Prospects

In view of discourses pertaining to the topic for this paper, it is an affirmation that the way forward for Africa and more so, SSA economies is to ensure high level of investment is dedicated in the direction of utilising human potential to capacitate human development. In this regard, it is noticeable that the creativeness of early-year learners are not so well utilised, particularly in national development planning as a way of exposing them to the vagaries of opportunities that can be gained through their exposure to innovative technologies.

The technological roadmap as presented in Figure 1 is a worthwhile considered ingenuity that attest to the need for alerting the relevance of investment at the early-year level to ensure the SSA region is capacitated with the opportunity of becoming an admirable society for the transfer of future technologies. In that vein, there is a need for governments (more so the public service) to prioritize investments at the early-year level so that present generation of children will be seen as genus for future creative innovations in the SSA region. Equally, higher educational establishments must seek to work collaboratively with stakeholders to make sure people are highly trained to support the cognitive state of children's ability to make use of their environments as dictated by the present pace of innovative technologies.

Disclaimer

Views expressed in this paper are those of the author and do not in any way reflect that of the named institution(s).

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