# THE STATUS OF DIGITAL INNOVATION AND DATA SECURITY IN SOUTH AFRICAN HIGHER EDUCATION

**K. S. Adeyemo**
Department of Education Management and Policy Studies
University of Pretoria, Groenkloof Campus
Pretoria, South Africa
http://orcid.org/0000-0001-9613-9418

ABSTRACT

Most Higher Education Institutions (HEIs) in South Africa have moved teaching and learning to online platforms due to the COVID-19 pandemic. With this new development, the responsibility falls upon HEIs to ensure the security of their data. The policy expectation is that HEIs adopt innovative strategies to manage disruptions in teaching and learning processes. This article problematises digital innovation as a post-COVID strategy for data security in Higher Education (HE) in South Africa. It uses the Model of Enterprise Intelligence to make a case for digital innovation and the transformation of teaching and learning in South Africa. Within this conceptual framework, evidence from literature and the digital policies from 2004 to 2020 (see Table 1) were analysed to have a better understanding of digital innovation, collaboration, and transformation in South Africa. Methodologically, the article reviewed the literature, secondary data, and the South African policy document on National Digital and Future Skills Strategy (Notice 513 2020). The findings show that the status of digital innovation and data security in South African Higher Education need further review. More specifically, this review should be collaborative, eliminate a top-down approach to digital policy formulation and reduce the effect of inequality through an effective funding for poor students and institutions.

**Keywords**: Higher Education, digital innovation, data security, digital policies, South Africa

## INTRODUCTION

Globalisation has been mostly responsible for the digital disruptions making waves across various Higher Education systems over the years (Lemoine and Richardson 2019). However, the recent increase in the use of digital technologies can mainly be attributed to the current COVID-19 pandemic (Vargo et al. 2021). Alas, these disruptions have made data management in teaching and learning to be an even more intricate process for staff with limited technological experience (Marks et al. 2021). Though South Africa has made some progress compared to other developing countries (Manda and Backhouse 2017), the recent pandemic has highlighted further need for more effective digital transformation policies in terms of vision 2030. The policy context, history and systemic issues in South Africa could assist in review progress made

in terms of vision 2030. In 2020, the South African Department of Communication and Digital Technologies published the Digital and Future Skills Strategy, which provided a road map for collaboration among stakeholders in various sectors including in the education sector (White Paper 2020). The expectation is that this strategic document should assist stakeholders in creating innovative ideas in teaching and learning. Given the history of South Africa and unresolved issues of social inequality, it cannot be assumed that all institutions have the ability, capability, and resources or are even ready to respond to digital disruptions (see Tustin, Goetz, and Basson 2012).

The digital strategy framework (White Paper 2020) of the South African government aims to build digital awareness through funding, research, and coordination. Moreover, the framework expects to improve quality education and economic growth through enhanced digital skills. While this strategy provides an expectation for improved teaching and learning during COVID-19 pandemic, it also poses questions of data risk and security (Motala and Menon 2020). The digital strategy policy (White Paper 2020) is relatively new, and it is unlikely that many HEIs in South Africa are fully ready for its implementation. Perhaps, what most institutions need during this pandemic is a greater collaboration through digital innovation and technology. For instance, digital transformation in teaching and learning requires financing and a great investment (see Badat 2020). Meanwhile, the budget for public Higher Education is declining and a lot of universities are now struggling even more during this COVID-19 pandemic (Van Schalkwyk 2021). A decision must be made whether to invest in new technologies to sustain student enrolment. Regardless, universities must embrace the realities of digital disruptions due to COVID-19 and formulate a strategy to manage its effects (Mhlanga and Moloi 2020). This article analyses the South African government digital strategy (White Paper 2020) to determine its adequacy in managing teaching and learning processes during the COVID-19 pandemic.

This research hopes to find out how digital strategy can improve the process of developing digital platforms for quality Higher Education in South Africa. The policy expectation is that Higher Education Institutions should be able to build their own digital tools. This research reveals the status of digital innovation and security, realities, and challenges of policy. The article further articulates the financial aspect of the strategy and the likelihood of institutions to develop a digital platform for teaching and learning. The argument was made for institutional collaboration strategy, where well-resourced institutions could possibly partner or provide support to institutions in rural areas, for example. Finally, the analysis includes decisions and implications to either buy, invest, acquire, or incubate learning platforms by the institutions. This policy article can be used to disrupt various educational services' market in globally and

especially in South Africa.

## THEORETICAL CONSIDERATION: THE MODEL OF ENTERPRISE INTELLIGENCE IN DIGITAL TRANSFORMATION

The teaching and learning process has changed due to digital disruptions (Avgerinou and Moros 2020) and the recent COVID-19 pandemic. As such, Higher Education Enterprises are now using different digital models to transform their operations (Watermeyer et al. 2021). The research shows that countries and institutions that either refuse or are slow in adopting digital innovation will not be able to compete in curriculum, enrolment, teaching, and assessment (Oliveira et al. 2021). It has been reported that more than 1,500,000,000 students worldwide at different levels need a quality education service during the pandemic (see Teräs et al. 2020). The competition is stiff, and many universities are now offering their major programmes online (Gamage, Silva, and Gunawardhana 2020). While some have a model of operation, most still struggle to provide quality teaching and ensure the security of assessment through their online systems (see Rapanta et al. 2020).

To transform and reorganise Higher Education systems digitally, Intelligent Enterprise Model (IEM) (Grundspenkis 2002; Thannhuber 2006) can be adopted. This IEM theoretical concept can be used, where most academics are working from home, and less contact with students is required. The reason why IEM can be used is because it provides good framework for analysing both micro and macro issues regarding the implementation of digital learning in higher education. Regardless of the size and resources of the institutions, the model – if used well – can ensure the security of quality education data and information on learning platforms (Wereda 2018). However, this model assumes there is a well-established information technology department (see Nguyen et al. 2018). The danger of not using digital innovation well in teaching and learning processes could result in reputation damage, if there is a breach in data security (see Trcek 2004).

The model of key components of an intelligent enterprise articulates the essence of Higher Education's role in training employees to work with a digital system (see Azarenko et al. 2018). Lack of training, therefore, may results in situations where teaching and learning could be greatly affected due to academics' technological inexperience. This is the same for students, particularly those living in South Africa's rural parts, where internet access is limited or where students have limited technological ability (see Du Preez and Le Grange 2020).

While digital learning platforms can improve communication, they can also prove to be a liability, if the technology is not well designed. The IEM shows how quality service can be

delivered if collaboration is allowed in the organisation (Andrius, Putinas, and Ramūnas 2006), and this could be achieved with a robust long-term agreement between HEIs and technology companies.

To achieve digital transformation for teaching and learning, it is important to pay attention to cyber security issues (Singar and Akhilesh 2020). This aspect requires training and education in this field. The model of Intelligence Enterprises emphasises the need to understand the framework of organisational change to provide technology service in teaching and learning (Thannhuber 2006). It is likely that the reputation of Higher Education will not only be judged by ranking only – students are now looking for flexibility in learning on universities' websites. Indeed, COVID-19 has proved that online learning can work and be made secure. However, there is no evidence that all institutions will neither survive the pressure posed by the pandemic nor the urgency to provide quality online education globally (Bozkurt et al. 2020).

Another key aspect of this theoretical concept of Enterprise Intelligence is Platform Revolution (see Parker, Van Alstyne, and Choudary 2016). The recent situation globally has motivated businesses to conduct their businesses on different digital platforms. In fact, Higher Education is not excluded from this trend. Thus, the teaching and learning process must create good experiences for students. For example, students would expect to easily locate their study material, information about assignments, examinations, and their marks on an institution's digital platform (Bonfield et al. 2020). Platform revolution is a continual improvement exercise and can be greatly improved by student feedback. In revolutionising digital platforms, institutions must decide whether to buy a technology licence, build digital learning platforms, partner with technology companies, or incubate (see Sawangchai et al. 2020). The strategy to buy means that institutions have the financial means and resources to invest on licencing or to acquire already developed digital learning platforms. This strategy could be very expensive but could generate an almost immediate response to the challenges posed by the COVID-19 pandemic. The downside of this strategy is that the acquired platform may not fit well with the operation of the institution. Therefore, proper assessment by the information technology department is essential in ensuring its viability, as well as guaranteeing the legality of acquiring the platform. Secondly, if an institution decides to build a digital learning platform, it could be costly and would require time to build it. Before taking that route, it is primordial to determine whether there is expertise in building a completely new learning platform. For institutions with very limited resources, the strategy to partner or collaborate is an aspect of Intelligence Enterprise model that should be considered. Finally, institutions could decide to incubate (see for example, Ross, Beath, and Mocker 2019). This means that a

budget should be allocated to sponsor research and development to derive intellectual benefits in the organisation. Many institutions in developed countries have adopted this approach and are now enjoying the benefits during digital disruptions and the COVID-19 pandemic.

On the other hand, there is no one-size-fit-all in the model of Enterprise Intelligence because institutions are varied in terms of their ability to provide resources and respond to digital disruptions and pandemics. Regardless of the strategy adopted, there is a great need to invest. The aim of Intelligence Enterprises in Higher Education is to ensure a Platform Revolution where universities ensure a common platform to distribute educational services. Both the institutions and Council on Higher Education (CHE) in South Africa need collaboration to strengthen digital strategy policies. The model of Enterprise Intelligence provides a conceptual perspective to analyse different dimensions of digital disruptions and what it means for the workforce in Higher Education business. Higher Education organisations in South Africa should be training employees to work with a digital system. The Intelligence Enterprises ideas can be applied to further examine how institutions are improving their information technology departments to ensure data secured websites or responsiveness. Within this framework, it will be interesting to examine how stakeholders are collaborating in building digital skills awareness, research and monitoring on digital skills, coordination across government and stakeholder groups and funding for digital skills. Likewise, this model is used to determine the success of implementation of digital strategy objectives in terms of the implications for economy, society and education, cyber security, monitoring and evaluation (see White Paper 2020).

## RESEARCH METHODOLOGY

This conceptual article adopts a document analysis design to understand the status of digital innovation and data security in the South African Higher Education sector. The related policies on digitalisation in South Africa from 2004 to 2020 were collated, sorted and most relevant policies selected (see Altheide et al. 2008). After this process, 11 polices were selected and analysed. After the analysis, four themes were derived and used to make case for the focus of this article. The relevant digital strategy and policy documents in South Africa from 2004 to 2020 were analysed based on the conceptual understanding of Enterprise Intelligence for digital capability of Higher Education Institutions. Empirical evidence was obtained from the literature assessment in terms of the objectives of the recent National Digital and Future Skills Strategy of the Department of Communication and Digital Technologies. The focus of the digital strategy and policies were critically examined and categorized (see Table 1 and 2).

**Table 1:** Relevant South Africa digital strategy and policy documents (2004–2020)

| Policy/Strategy documents | Focus |
|---|---|
| White Paper on e-Education: Transforming Learning and Teaching through Information and Communications Technologies (ICTs) (DoE 2004) | To ensure optimal availability and use of ICTs in education |
| National Skills Accord 1 (DEDT 2011) | To improve the funding of training among others |
| South Africa Connect: South African Broadband Policy (DCDT 2013) | For seamless information infrastructure by 2030 |
| White Paper for Post-School Education and Training, 2013 | It recognises the importance of partnerships for vision 2030. |
| National Integrated ICT Policy White Paper, 2016 | Aims to use communication to transform socio-economy situation of South Africa. |
| The Third National Skills Development Strategy (DHET 2019) | Providing access to high quality training and education. |
| South Africa's National e-Strategy (DTPS 2017) | Digitalization of government services. |
| National e-Government Strategy and Roadmap (DTPS 2017) | Using digital technologies to improve the quality of life of South Africans. |
| Professional Development Framework for Digital Learning, 2017 | Improving digital skills of teachers. |
| GITOC digital government strategy, 2018 | Providing quality public service |
| National Digital and Future Skills Strategy, 2020 | Ensuring digitally skilled South African society |

From these strategies and policies, four themes were identified, and analysed in terms of their ability to create and support digital innovation, collaboration, and transformation in South Africa. Finally, status of digital innovation and security in the country was considered. Special attention were paid to the expectations of policy/strategy documents and whether they are adequate to support the implementation of digital transformation in the South African Higher Education sector.

**Table 2:** Themes and policies related to digital innovation in South Africa

| Themes | Relevant Strategy/Policy Documents | Recommendation |
|---|---|---|
| Creating and using digital innovation | • White Paper on e-Education: Transforming Learning and Teaching through Information and Communications Technologies (ICTs), 2004 | • Funding<br>• Training<br>• Grassroot policy design |
| Collaboration for digital innovation | • White Paper for Post-School Education and Training, 2013 | • Partnership and collaboration on latest skills |
| Digital transformation for equal South Africans | • National Skills Accord, 2011 | • Funding<br>• Relevant technology skills agenda |
| Status of digital transformation in South Africa | • National Digital and Future Skills Strategy, 2020 | • Inclusivity in distributing digital skills and opportunities |

## CREATION AND USE OF DIGITAL INNOVATION

Studies have emphasised the importance of investing in digital technology in Higher Education consistently (see Jirgensons and Kapenieks 2018). Globally, many institutions have now been devoted to creating innovative learning platforms for effective teaching. This situation has also led to the proliferation of digital learning platforms for institutions that were initially critical of

online and distance learning (Kumar et al. 2021). There is strong evidence suggesting that after the emergence of COVID-19, institutions of higher learning foresaw the possibility of being excluded from global trends should they fail to include digital innovation in their educational operation (Toquero 2021). In 2004, South Africans introduced a white paper on Information Communication Technology (ICT) and encouraged education institutions to embrace it for any serious digital disruptions in teaching and learning (Department of Education, White Paper on e-Education: Transforming Learning and Teaching through Information and Communications Technologies (ICTs), 2004). The importance of this document is the intention of the government to promote technological innovation in teaching and learning post-1994. However, COVID-19 has moved the pace of ICT beyond this level.

To empower institutions' ability to adopt digital innovation in Higher Education in South Africa, access to adequate funding and issue of ethics are important. Funding and ethics are also linked to quality education and outcomes (Kayembe and Nel 2019). Therefore, assessing Higher Education readiness for digitalisation goes beyond statements in the policy and strategy documents. There is a need to audit for readiness to use digital technologies for teaching and learning (see Department of Telecommunication and Postal Services, South Africa's National e-Strategy and Roadmap, 2017). This audit should be conducted with the intention to not only identify the needs but to develop a new funding formula for funding technological innovation.

The number of students enrolling to study online programmes are increasing in South Africa and it includes students from rural areas that have enrolled in historically white institutions (Dube 2020). This has two implications: an implication for institutions to enhance their technologies for teaching and learning for all, and an implication for students from rural areas in terms of access to technology to benefits from new technological innovations (see for example Department of Communication, South African Connect: South African Broadband Policy, 2013). The Commission on Higher Education (CHE) has a history of ensuring quality national frameworks for all Higher Education for many years. This may start changing if students in online programmes are not ready for it. The implications of this in a long run is that the quality of programmes and degrees will start to fall in many rural universities (see Dube 2020). While readiness assessment to use technology is necessary, it may be important to develop separate policy guidelines (in National Digital and Future Skills Strategy) (White Paper 2020) for universities that are moving their contact programmes to online digital platforms due to the pandemic.

Before the pandemic, the number of students dropping out of their registered programmes had increased (Letseka and Maile 2008). It is likely that several students will not drop out mostly for academic reasons during COVID-19 but will mainly do so due to their inability to

use technology to learn (Mawere and Sambo 2021). Government idea of digital transformation is for everyone to access (Department of Telecommunication and Postal Services, The National e-Government Strategy and Roadmap, 2017). It appears certain that inequality first needs to be addressed before the implementation of digital transformation strategies (Jain et al. 2020). Since the occurrence of the pandemic, unemployment is on the rise, which has subsequently had a great effect on the quality of life which has diminished in turn. Nonetheless, the policy is not explicit about how poverty can be alleviated to ensure digital transformation in society (Digital and Future Skills Strategy) (White Paper 2020).

If the popular mode of delivery for many institutions is now virtual teaching, a lot of South African students mostly from rural areas are likely to be excluded in Higher Education during this pandemic. Online learning requires certain competencies in using technology and computer literacy. There is a need to also have access to a computer with some required applications. These pre-requisites to starting the learning process require an investment that were mostly not included in student funding before the pandemic and the policy did not clearly indicate how to support students in this category. Department of Higher Education and Training, National Skills Development Strategy (2019) aims to increase the opportunity to learn skills including computer skills. What this document should have articulated is monitoring strategies to ensure that these opportunities target high school students so that they are technologically equipped before they get to universities. Students' academic performance is likely to be affected if teaching and learning occurs digitally at varsity. In South Africa today, digital transformation in Higher Education should mean an improved quality of life and access to technology opportunities for all (see Economic Development Department, National Skills Accord 1 2011).

The key to creating an effective digital transformation in South Africa is through collaboration. First, there is a need to determine whether the key aspects of the digital strategy and policies are aligning with the transformation agenda or policies (see National Integrated ICT Policy White Paper) (Notice 513 2020). The assessment of the policy documents did not show a clear alignment to the manner in which institutions intend to help government improve South Africans' quality of life on South Africans through education that are offered on digital platforms. The collaboration between government and institutions are key. Collaboration with other stakeholders will determine whether the policies should not be improved to reflect and develop from grassroot. The Department of Basic Education, Professional Development Framework for Digital Learning, (2017) may need to highlight different aspects of digital skills that educators need to learn to be better teachers. Indeed, the new normal due to COVID-19 present new ways of teaching and learning. For this reason, a lot of computer and learning applications have been updated. Ensuring quality education would mean that the professional

development for teachers in digital learning should be adequately funded. For instance, teachers are now expected to create online learning material, develop online rubrics, and also provide feedback to students including virtual teaching with different functionalities. This is new to some teachers and has also increased workload in a way. Teachers who are not regularly updated or have access to the latest technological development may not be effective in this era. In many rural schools, this is a big challenge. If technological ability is included as part of the admission criteria to access universities (it is most likely), it is likely that many students from rural areas may not be qualified.

## COLLABORATION FOR DIGITAL INNOVATION

Policy formulation in South Africa cannot be simple. There is a constant reminder to consider the diversity aspect and the issue of societal inequality in the deliberation processes (Conradie 2018). The digital design requires this type of democratic consultation in creating digital policy (see National Digital and Future Skills Strategy) (Notice 513 2020) for Higher Education (see D'Ambruoso et al. 2019). Another form of collaboration is required at institutional level where policies will be implemented. At this stage, relevant stakeholders are consulted on the feature for digital innovation for the Higher Education system (Monareng, Ramraj, and Mashau 2020). This process is not to create uniformity in terms of education technologies. It only ensures participation and collaboration between relevant stakeholders during policy formulation and before policies digitalisation are implemented.

The recent trend shows that institutions are collaborating more in terms of sharing technology, policy and ideas. One challenge is a situation where well-established universities may only partner with each other (see for example, Buitendijk et al. 2020). The implication of such a situation is that the focus of some institutions will shift if they continue to struggle in finding partnerships. Teaching institutions may slowly shift their focus more on research and it is likely that certain institutions may cancel some of their programmes if they are undescribed due to a lack of technology capacity to deliver them. The kind of collaboration that is required should see more capable institutions collaborating with institutions that need help. Due to an increase in competitions for rankings and reputation, many smaller institutions will not have access to collaborations that can sustain their operations during the COVID-19 pandemic and in this era of digital disruptions. In a way, this is another problem related to globalisation and regionalisation. The idea of globalisation promotes integration and collaboration in text. In reality, only under resourced universities in many developing countries may be collaborating or struggling to collaborate (South Africa for example) (Mutemeri and Chetty 2011). This has made academics to continue to challenge the motivation for globalisation of knowledge and

what it means for universities in Africa in the era of the COVID-19 pandemic.

In South Africa, there is still evidence of inequality in terms of resources sharing and this often depends on whether the institution is public or private (see for example, Wangenge-Ouma 2010). In this situation, collaboration in technology between poor and rich universities may be limited for reasons such as status and reputation. Many of the well-resourced and historically white institutions were already equipped with some of the technology meant to deliver quality teaching. On the other hand, it is not unlikely that few of them might still be lagging. For instance, academics in some universities in South Africa could not use technology well (Chigona and Dagada 2011). It is likely that many of these academics will not be effective in the era of digital innovation and pandemic, if they have not updated their skills. If this is the case, the situation might be worst for historically black institutions where resources are very limited. To achieve the goal of digitalisation for an equal society (National Digital and Future Skills Strategy) (Notice 513 2020), it is fundamental to ensure that funding for universities is distributed efficiently and fairly. The situation of unequal distribution of national resources has not changed much since 1994 and this could have serious implications for the creation and ability to use digital technologies for some institutions in the country.

## DIGITAL TRANSFORMATION TO COMBAT INEQUALITY IN SOUTH AFRICA

Digital transformation could become clearer in South Africa because the recent pandemic is revealing unequal opportunities in education (see Mhlanga and Moloi 2020; Manda and Backhouse 2017). This awareness is critical to develop an evidence-based digital transformation strategy that will remove barriers to opportunities to succeed in Higher Education regardless of race, gender, and social status. This aspect needs transformation for digital transformation to thrive in South Africa (Mhlanga 2020).

Due to COVID-19 complications, many people have died including academics of various institutions (Stiegler and Bouchard 2020) and recruitment will be faced with a major challenge post-COVID-19. So, creating a sustainable digital transformation also requires staff to manage them. There is a constant request to create digital technologies in education that requires fewer human efforts. This will further worsen the unemployment rate that is already high in the country. Some academics are concerned about the integrity of academic awards in a situation where all the education activities took place online with less human efforts. The argument is that the high likelihood of academic cheating or fraud will be high. Some institutions in advanced countries are now using online proctoring tools to conduct online examination for their students. This type of advanced digital innovation is not very popular in Africa and in South Africa. Hence, Higher Education is faced with dilemma of urgency need to offer

programmes online and create sophisticated digital technologies to manage its integrity. This is what the policies on digital transformation should be focusing on. There is a need for the policy review of digital transformation in South Africa, otherwise, important skills that are needed for sustainable development goals of the country may not be available because of the drop-out rate. In other words, the 2030 sustainable development vision may not be realised due to the serious digital disruptions that has put strain on the government budget and the need to provide quality education on virtual platforms.

## CONCLUDING REMARKS

This article has examined policy and strategy documents relevant to promote digital transformation in South Africa from 2004 to 2020. Evidence from literature were reviewed, considered, and analysed in relation to the readiness of Higher Education systems to implement effective digital technologies for teaching and learning. The conceptual framework on Intelligence Enterprises for digital transformation was used as a tool of analysis to better understand how creating digital technologies and collaboration can be well aligned to achieve positive results in a multicultural society such as South Africa.

The analysis shows the openness of the South African government to transform the economy and education through technology post-apartheid. Several policy documents were introduced to demonstrate efforts of the government to transform South Africa into an equal society in education. While these policies were critical of the past and aim to redress the inequality in education, they were developed from a political mind-set and often used a top-down approach. There is no strong evidence that the tone of the documents understands what is happening at grassroot very well. For example, the digital policies developed almost assumed that the institutions have the same level of ability and capacity to implement digital technologies. Similarly, the design of the policy document framed the implementation to achieve government objectives of transforming economy. As a result, the focus was on the skills that educators should develop to teach well and promote quality of life through training.

The objectives of some of these policies are broad and did not indicate how big/rich/well-established institutions could partner with small/poor institutions to build capacity in digital innovation in the South African Higher Education sector. Collaboration was identified as a crucial element of the Enterprise Intelligence for effective implementation of digital technology. While collaboration is crucial, it will be difficult in South Africa where competitions among universities in terms of ranking and reputation are strong. There is the possibility that many teaching institutions will cancel many of their academic programmes during the pandemic because of lack of collaboration and inadequate funding available to deliver digital learning and maintain data security.

## REFERENCES

Altheide, D., M. Coyle, K. DeVriese, and C. Schneider. 2008. "Emergent qualitative document analysis." *Handbook of emergent methods*, 127–151.

Andrius, B. A., B. Putinas, and P. Ramūnas. 2006. "Developing of an intelligent enterprise staff electronic learning component." *IFAC Proceedings Volumes* 39(3): 747–752.

Avgerinou, M. D. and S. E. Moros. 2020. "The 5-phase process as a balancing act during times of disruption: Transitioning to virtual teaching at an international JK-5 school." In *Teaching, technology, and teacher education during the COVID-19 pandemic: Stories from the field*, 583–594. Waynesfield, NC, USA: Association for the Advancement of Computing in Education (AACE), 15 Jun.

Azarenko, N. Y., O. V. Mikheenko, E. M. Chepikova, and O. D. Kazakov. 2018. "Formation of innovative mechanism of staff training in the conditions of digital transformation of economy." In *2018 IEEE International Conference Quality Management, Transport and Information Security, Information Technologies" (IT&QM&IS)*, 764–768. IEEE.

Badat, S. 2020. "Reproduction, transformation and public South African Higher Education during and beyond Covid-19." *Transformation: Critical perspectives on Southern Africa* 104(1): 24–42.

Bonfield, C. A., M. Salter, A. Longmuir, M. Benson, and C. Adachi. 2020. "Transformation or evolution? Education 4.0, teaching and learning in the digital age." *Higher Education Pedagogies* 5(1): 223–246.

Bozkurt, A., I. Jung, J. Xiao, V. Vladimirschi, R. Schuwer, G. Egorov, ... and M. Paskevicius. 2020. "A global outlook to the interruption of education due to COVID-19 pandemic: Navigating in a time of uncertainty and crisis." *Asian Journal of Distance Education* 15(1): 1–126.

Buitendijk, S., H. Ward, G. Shimshon, A. H. Sam, D. Sharma, and M. Harris. 2020. "COVID-19: An opportunity to rethink global cooperation in Higher Education and research." *BMJ Global Health* 5(7): e002790.

Chigona, A. and R. Dagada. 2011. "Adoption and use of e-learning at tertiary level in South Africa: A qualitative analysis." In *Global Learn,* 93–101. Association for the Advancement of Computing in Education (AACE).

Conradie, I. 2018. "Social Policy in South Africa: The challenges of Poverty, Inequality and Exclusion." *Social Work & Society* 16(2).

D'Ambruoso, L., M. van der Merwe, O. Wariri, P. Byass, G. Goosen, K. Kahn, ... and R. Twine. 2019. "Rethinking collaboration: Developing a learning platform to address under-five mortality in Mpumalanga province, South Africa." *Health Policy and Planning* 34(6): 418–429.

Department of Basic Education. 2017. *Professional Development Framework for Digital Learning*. https://www.education.gov.za/Portals/0/Documents/Publications/Digital%20Learning%20Framework.pdf?ver=2018-07-09-101748-95. (Accessed 28 April 2023).

Department of Communications and Digital Technologies. 2013. South African Connect: South African Broadband Policy. *Government Gazette, 36332.* https://archive.opengazettes.org.za/archive/ZA/2013/government-gazette-ZA-vol-574-no-36332-dated-2013-04-03.pdf. (Accessed 28 April 2023).

Department of Education. 2004. White paper on e-education: Transforming learning and teaching through information and communication technologies (ICT's). *Government Gazette*, *26762*. https://www.gov.za/documents/white-paper-e-education-transforming-learning-and-teaching-through-information-and. (Accessed 28 April 2023).

Department of Higher Education and Training. 2019. The Third National Skills Development Strategy. *Government Gazette, 42290.* https://www.merseta.org.za/wp-content/uploads/2021/04/Promulgation-of-the-National-Skills-Development-Plan.pdf. (Accessed 28 April 2023).

Department of Telecommunication and Postal Services. 2017. South Africa's National e-Strategy and Roadmap. *Government Gazette, 41214.* https://www.gov.za/sites/default/files/gcis_document/

201711/41241gen886.pdf. (Accessed 28 April 2023).

Du Preez, P. and L. Le Grange. 2020. "The COVID-19 pandemic, online teaching/learning, the digital divide and epistemological access." Unpublished paper.

Dube, B. 2020. "Rural online learning in the context of COVID 19 in South Africa: Evoking an inclusive education approach." *Multidisciplinary Journal of Educational Research* 10(2): 135–157.

Economic Development Department. 2011. National Skills Accord 1. https://www.gov.za/sites/default/files/gcis_document/201409/ngpdboeredaccordschools3.pdf. (Accessed 28 April 2023).

Gamage, K. A., E. K. D. Silva, and N. Gunawardhana. 2020. "Online delivery and assessment during COVID-19: Safeguarding academic integrity." *Education Sciences* 10(11): 301.

Grundspenkis, J. 2002. "Concept of Intelligent Enterprise Memory for Integration of Two Approaches to Knowledge Management." In *Databases and Information Systems II*, 121–134. Springer, Dordrecht.

Jain, R., J. Budlender, R. Zizzamia, and I. Bassier. 2020. *The labor market and poverty impacts of covid-19 in South Africa*. SALDRU, Cape Town.

Jirgensons, M. and J. Kapenieks. 2018. "Blockchain and the future of digital learning credential assessment and management." *Journal of Teacher Education for Sustainability* 20(1): 145–156.

Kayembe, C. and D. Nel. 2019. "Challenges and opportunities for education in the Fourth Industrial Revolution." *African Journal of Public Affairs* 11(3): 79–94.

Kumar, R., S. Bhalla, T. Arora, and M. Kumar. 2021. "Proliferation of Digital Education in Times of COVID19." Available at SSRN 3832715.

Lemoine, P. A. and M. D. Richardson. 2019. "Creative disruption in Higher Education: Society, technology, and globalization." In *Educational and social dimensions of digital transformation in organizations*, 275–293. IGI Global.

Letseka, M. and S. Maile. 2008. *High university drop-out rates: A threat to South Africa's future*. Pretoria: Human Sciences Research Council.

Manda, M. I. and J. Backhouse. 2017. "Digital transformation for inclusive growth in South Africa. Challenges and opportunities in the 4th industrial revolution." In *2nd African conference on information science and technology*. Cape Town, South Africa.

Marks, A., A. A. Maytha, R. Attasi, A. A. Elkishk, and Y. Rezgui. 2021. "Digital transformation in Higher Education: Maturity and challenges post COVID-19." In *International Conference on Information Technology & Systems*, 53–70. Springer, Cham.

Mawere, T. and P. Sambo. 2021. "Technology and Its Impacts in Higher Education Post COVID-19." Available at SSRN 3817344.

Mhlanga, D. 2020. "Industry 4.0: The Challenges Associated with the Digital Transformation of Education in South Africa." *The Impacts of Digital Transformation* 13.

Mhlanga, D. and T. Moloi. 2020. "COVID-19 and the digital transformation of education: What are we learning on 4IR in South Africa?" *Education Sciences* 10(7): 180.

Monareng, J., A. B. Ramraj, and P. Mashau. 2020. "The rise in online learning in South African schools due to the Coronavirus pandemic." *Gender & Behaviour* 18(4).

Motala, S. and K. Menon. 2020. "In search of the 'new normal': Reflections on teaching and learning during Covid-19 in a South African university." *Southern African Review of Education with Education with Production* 26(1): 80–99.

Mutemeri, J. and R. Chetty. 2011. "An examination of university-school partnerships in South Africa." *South African Journal of Education* 31(4): 505–517.

Nguyen, H. D., N. V. Do, N. P. Tran, and X. H. Pha. 2018. "Criteria of a knowledge model for an intelligent problems solver in education." In *2018 10th International Conference on Knowledge and Systems Engineering (KSE)*, 288–293. IEEE.

*NOTICE 513*. 2020. 513. "National Integrated ICT Policy White Paper of 2016: National Digital and Future Skills Strategy." South Africa.

Oliveira, G., J. Grenha Teixeira, A. Torres, and C. Morais. 2021. "An exploratory study on the emergency remote education experience of Higher Education students and teachers during the COVID-19 pandemic." *British Journal of Educational Technology* 52(4): 1357–1376.

Parker, G. G., M. W. Van Alstyne, and S. P. Choudary. 2016. *Platform revolution: How networked markets are transforming the economy and how to make them work for you*. WW Norton & Company.

Rapanta, C., L. Botturi, P. Goodyear, L. Guàrdia, and M. Koole. 2020. "Online university teaching during and after the Covid-19 crisis: Refocusing teacher presence and learning activity." *Postdigital Science and Education* 2(3): 923–945.

Ross, J. W., C. M. Beath, and M. Mocker. 2019. "Creating digital offerings customers will buy." *MIT Sloan Management Review* 61(1): 64–69.

Sawangchai, A., H. Prasarnkarn, J. Kasuma, A. G. Polyakova, and S. Qasim. 2020. "Effects of COVID-19 on digital learning of entrepreneurs." *Polish Journal of Management Studies* 22(2): 502.

Singar, A. V. and K. B. Akhilesh. 2020. "Role of Cyber-security in Higher Education." In *Smart Technologies*, 249–264. Springer, Singapore.

Stiegler, N. and J. P. Bouchard. 2020. "South Africa: Challenges and successes of the COVID-19 lockdown." In *Annales Médico-psychologiques, revue psychiatrique* 178(7): 695–698. Elsevier Masson.

Teräs, M., J. Suoranta, H. Teräs, and M. Curcher. 2020. "Post-Covid-19 education and education technology 'solutionism': A seller's market." *Postdigital Science and Education* 2(3): 863–878.

Thannhuber, M. J. 2006. *The intelligent enterprise: Theoretical concepts and practical implications*. Springer Science & Business Media.

Toquero, C. M. 2021. "Emergency remote education experiment amid COVID-19 pandemic." *IJERI: International Journal of Educational Research and Innovation* (15): 162–176.

Trcek, D. 2004. "E-business systems security for intelligent enterprise." In *Intelligent Enterprises of the 21st Century*, 302–320. IGI Global.

Tustin, D. H., M. Goetz, and A. H. Basson. 2012. "Digital divide and inequality among digital natives: A South African perspective." *African Journal of Business Management* 6(31): 9140–9150.

Van Schalkwyk, F. 2021. "Reflections on the public university sector and the covid-19 pandemic in South Africa." *Studies in Higher Education* 46(1): 44–58.

Vargo, D., L. Zhu, B. Benwell, and Z. Yan. 2021. "Digital technology use during COVID-19 pandemic: A rapid review." *Human Behavior and Emerging Technologies* 3(1): 13–24.

Wangenge-Ouma, G. 2010. "Funding and the attainment of transformation goals in South Africa's Higher Education." *Oxford Review of Education* 36(4): 481–497.

Watermeyer, R., T. Crick, C. Knight, and J. Goodall. 2021. "COVID-19 and digital disruptions in UK universities: Afflictions and affordances of emergency online migration." *Higher Education* 81: 623–641.

Wereda, W. 2018. "Creating a brand of the intelligent enterprise through building relationships with stakeholders." *Modern Management Review* XXIII 25(4): 247–275.

White Paper. 2020. *Digital and Future Skills Strategy*. The South African Department of Communication and Digital Technologies.