Reimagining curricula for the Fourth Industrial Revolution[1]

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ABSTRACT

If higher education is to deliver education to students that prepares them for the demands and challenges of the Fourth Industrial Revolution (4IR), new flexible curricula and teaching approaches for diverse contexts and a move away from a teleological view of 'skills' are required. The 2009 establishment of a dedicated Ministry for Higher Education and Training led to a (then) new perspective in terms of the organisation of the post-school education and training landscape which has had as its aggregated effect a heightened government focus on the link between education, the economy, and skills development. New approaches to curricula specifically and to programme types essential for a more empowering pedagogy for the 4IR are needed. Curricula to serve these ends are not supported by the current focus on predefined categories and types of learning. The changes in teaching technologies and tools have not been matched by flexibility in the processes and policies designed to ensure quality in higher education which increasingly frustrate attempts to respond effectively. The existing framework requires imaginative rethinking about curriculum to address the current and future needs of students.

Keywords: 4IR, flexible curricula, higher education, transformation, pedagogies, learning programmes

INTRODUCTION

In 2015, Klaus Schwab wrote:

> We stand on the brink of a technological revolution that will fundamentally alter the way we live, work, and relate to one another. In its scale, scope, and complexity, the transformation will be unlike anything humankind has experienced before.

He termed this the Fourth Industrial Revolution (4IR). In 2019, higher education institutions are just beginning to react and to respond to what he characterised as a revolution happening 'at an exponential rather than a linear pace' (Schwab, 2016). South Africa (SA) is a hybrid mix, with some sectors in society transitioning between the second, third and fourth revolutions, not losing sight that the 4IR has the potential to impact on the country in socio-economic ways. The 4IR has been characterised by an increased emphasis on technologisation, with its advent being heralded in terms such as 'the robots are

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coming', which could result in a period of 'technological unemployment' (Peters, 2017: 1). Whether it is a case of the technologisation of contemporary human life resulting in fewer jobs, or whether it will release people to do other, new kinds of work, there is no question that it will be necessary to rely on 'the ability of human labour to win the race against technology by means of education' (Frey & Osborne, 2013: 15). If education is to deliver on the needs of society in the face of this revolution, new curricula and teaching approaches will be needed.

Against this high-paced, rapidly transforming technological and human frenzy, questions of curricula in higher education institutions are central, as qualifications are the delivery vehicles from which graduates acquire the skills and knowledge needed for the world of work. A curriculum construct is designed to equip university students for either or both post-graduation employment or further study.[2] In practical terms, therefore, a curriculum construct is understood as the packaging of knowledge into modules and qualifications, with exit level outcomes and assessment criteria, the teaching and learning pedagogy, the role of the academic mediating the processes and the role of the students in engaging with the academic processes and the broader environment of the university. The World Economic Forum's 2017 report, 'The Future of Jobs and Skills in Africa', predicts that the 4IR will create disruptions (2017: 15) to many occupations but simultaneously will open new occupations especially in fields such as science, technology, engineering and maths (STEM), data analysis, computer science and engineering. It is envisaged that the demand will be for professionals who have a blend of digital and STEM skills with traditional subject knowledge. This could see for example, digital-mechanical engineers and business operations data analysts, who bring together deep knowledge of their industry with the latest analytical tools. Given the demands of the 4IR, a review of the extent to which the current available curriculum constructs are able to meet the most basic of these demands, is long overdue. In university terms, the four-year period since Schwab's 2015 alert is minimal; however, in advancement terms, it is an age.

Ornstein and Hunkins (2009: 15) offer a view that the understanding of curriculum development is fairly limited to how a 'curriculum is planned, implemented and evaluated, as well as what people, processes and procedures are involved'. They contend that this view excludes the human element in curriculum design. Barnett and Coate's (2005: 3) view of curriculum design is that there is a need to reshape 'spaces for learning'. It is the contention of this paper that a disruption of the spaces of teaching and learning has to occur if universities are to contend with the needs of current society and future societies. In order to teach for an 'unknown future', Barnett (2004: 1) argues that it is necessary to move beyond the cul-de-sac that is 'skills', and 'generic skills', 'the way forward lies in construing and enacting a pedagogy for human being' (sic), with the focus on 'human qualities and dispositions' as opposed to on what knowledge and skills (Barnett, 2004). Barnett and Coate (2005) define the concept of 'knowing' in 'Engaging the Curriculum in Higher Education' as follows:

> … a changing world does not rule out knowledge as such, but it poses questions as to what kinds of knowledge are going to be fruitful in a changing world. … In a curriculum for the twenty-first century, what matters is the student's own engagements with knowledge - in other words his or her knowing' (Barnett & Coate, 2005: 48).

HISTORICAL CONTEXT

Since 1994, South Africa has embarked on a number of shifts both systemically and structurally to the higher education sector. These shifts were designed to give effect to the broader political transformation agenda, to ensuring equitable access to higher education, and to providing skills to students which would, it was assumed, inevitably lead to employment opportunities. Prior to 1994, and in accordance with the

2 These are the twin purposes as set out in the Council on Higher Education (CHE) Accreditation Criteria.

dictates of apartheid Higher Education (HE), qualifications were tailored to meet the defined 'needs' of the various population groups. Badroodien (2004), Kraak (2004), and McGrath (2004) provide detailed historic vignettes of education under apartheid and it is clear that skewed skills development persists, particularly in the so-named Historically Disadvantaged Institutions (HDIs), where programmes were limited to those areas identified by the government to meet the specific needs of the black population (NCHE, 1996; DoE, 1996). Apartheid thus resulted in a 'highly contested and racially segregated higher education system' evident in the two-tiered, historically white and historically black universities (with two separate universities for Indians and 'coloureds') (Hay & Monnapula-Mapesela, 2009: 11). Badat (1994) asserts that access to HE was driven by parochial conceptions of labour market needs, premised directly on race, gender and class assumptions. Remarkably, and more than a decade post-apartheid, the Soudien report affirmed '… at the centre of epistemological transformation is curriculum reform – a reorientation away from the apartheid knowledge system, in which curriculum was used as a tool of exclusion, to a democratic curriculum that is inclusive of all human thought', a move critical to the success of democracy (Soudien et al., 2008: 90).

Under apartheid, technikons were restricted to offering legislated qualifications – the National Accredited Technical Education Diploma (NATED) programmes, a set of vocational programmes, with legislated curricula and requirements. The technical training system began at school level, culminating in programmes offered by technikons. By contrast, HE curricula were not regulated, and universities had almost complete freedom in determining curricula, programme structures, types and provisioning (Bunting, 1994).

The political changes of 1994 precipitated a series of massive shifts in policy in education broadly, and HE specifically. The promulgation of the Higher Education Act, Act 101 of 1997 triggered the processes to undo at multiple levels, the legacies of apartheid. The South African Qualifications Authority (SAQA) adopted an outcomes-based education (OBE) approach to HE. This set in place the boundaries within which the so-called 'graduate attributes' could be established, based on the assumption that the provision of certain learning materials, taught in the newly identified mode of OBE would result in the achievement of these outcomes (Griesel & Parker 2009: 15). In Allais's words (2003: 1), there were '[m]any hopes … pinned on the NQF' which would, it was thought, be the mechanisms through training and education that would 'integrate' to meet the transformation needs of the community and industry (Allais, 2003: 2). This virtually magical transition and the reforms triggered by the regulatory bodies would be achieved through the instruments of audit, accreditation, and registration effected by three bodies: the Council on Higher Education (CHE), SAQA and the Department of Higher Education (DHET).

The graduate attributes seen as ideal and encapsulated in the Critical Cross Field Outcomes (CCFOs) were ostensibly the generic skills all students ought to acquire on completion of a qualification. Each qualification had a set of academic or learning outcomes and the CCFOs were generic to all as contributors to SA's initiatives to transform itself through the key driver identified by these bodies as 'employability'. Without employable, skilled graduates, the argument proceeded, the South African economy would not succeed, and the resulting political and socio-economic transformation would not be achieved. The language employed in respect of education is evident in the broad policy documents of the DHET which state the need to develop 'a skilled and capable workforce to support an inclusive growth path' (The Presidency, 2010). The preoccupation of 1990s policy on widening access and narrowing the rift between apartheid Higher Education Institutions (HEIs) created further synergies in the post-school education and training landscape which served further to heighten government's focus on the link between the economy and skills development (subsumed into HE). In the Minister Blade Nzimande's words on 4 September 2012:

> … boosting the supply of skills has positive implications for both economic and social justice imperatives in South Africa. It ensures […] a continuous supply of the required skills for overall economic development …. (RSA, 2012)

In the broad area of curriculum, three phases can be seen: first, compliance with the National Qualifications Framework (NQF), promulgated in 1998; second, the National Plan for Higher Education (DoE, 2001); and finally, the passing of the Higher Education Qualification Sub-Framework in 2013. However, as Salim Badat (2010: 14) has argued, the mechanisms in place, and the view of education from which these arose, resulted in

> [a]n instrumental approach to higher education which reduces its value to its efficacy for economic growth, and calls that higher education should prioritize professional, vocational and career-focused qualifications and programmes and emphasise 'skills' development is to denude it of its considerably wider social value and functions'.

Furthermore, and as has been argued elsewhere (Menon & Castrillon, 2019), the very mechanisms through which transformation of the curriculum was to be achieved, may very well have served to stifle rather than to liberate the mechanisms of change. This paper examines the implications of this history for the present and the future, from the lens of the flexibility needed in contemporary and future-fit curricula.

Against this backdrop, the South African HE sector faces a number of challenging questions. Of course, one of these is the need to decolonise (about which much has been written, and which is not the focus of this paper). However, there are numerous others, including the question of the extent to which South African HE is able to produce graduates sufficiently well educated and ready for the 4IR (as opposed to having obtained a qualification which (in theory at least) enables them to obtain 'a job'). The broad question for the HE sector now is whether it is possible in 2019 to use the approach devised to respond to the problems identified at the dawn of democracy in 1994. It is argued that in order to address the current challenges, new understandings of curricula, programmes and qualifications are needed. The current frameworks (the CESMs, the HEQSF, the CHE programme standards, SAQA policies and so on) do not provide sufficient flexibility to allow institutions to address the challenges of the future. The current approach, context-bound as it is in its form and function, is not able to drive the kind of HE initiatives needed in HE currently (Menon & Castrillon, 2019).

It is worth reiterating that the main objectives of the 1994 initiatives were to radically shift and improve the quality of education to strengthen the linkage between it and the country's economy. Bhorat, Cassim and Tseng (2016) argue that HE has become valued for its perceived ability to increase labour productivity; to add to the innovative capacity of technology; and to facilitate the absorption of technology. However, the current shifts (in which technology is more overtly a means to an end than an end in itself), the nature and form of HE programmes into which HE providers are pushed need to be interrogated. It seems unlikely that the outcome-heavy, content-laden solutions which characterise the current HE qualifications are the best response to the needs of an as yet ill-defined future.[3] The more narrowly scoped for employment (or other purposes) a qualification is, the less likely it is that it will be able to address the needs of students. There is a strong argument to be made for an approach to learning programmes that focus directly on the development of skills, attributes and attitudes and that move away from the valuing of content for the sake of employment, especially in those qualifications where there is no direct link to employment (as is

3 The reader is directed, for example, to the recent publication of the Higher *Education Qualifications Sub-Framework Qualification Standard for Bachelor of Commerce, June 2019, V8*, which sets the base curriculum requirements to which all institutions must adhere in order to call a qualification a Bachelor *of Commerce degree*, to the extent of prescribing certain content for the degree (see p.7 of the *Draft Standard*). Thus, in addition to the requirements set out in the HEQSF, institutions are now to adhere also to the prescripts established in the various standards. The ever-diminishing level of detail and prescriptiveness to which the regulators resort is evidence, perhaps, that the system is not achieving the desired effect and that rather than undertaking a thorough re-evaluation of the system, ever-increasing layers of compliance are added in the vain hope that these will, in aggregation, bring about the desired result.

the case in several professional programmes, arguably). A better approach to higher education learning programmes may very well be one that signals a return to the model of degrees past: one in which disciplines, content and technologies are tools that serve the greater master of the skills for the future. As Osman points out 'Universities will need to ensure that students are equipped with approaches to learning that involve agility, adaptability and curiosity. It will be a challenge for us all' (The Conversation, 2018).

It is clear that the unemployment rate in SA means that attention must be paid to how people earn a living and what they will need to be able to do so. According to Stats SA, SA's current population is 57.7 million as of 1 July 2018 (Stats SA, 2018a). Alarmingly, the latest figures indicate that SA's unemployment rate is at 26.7%, for both youth and adults. However, the unemployment rate for people aged 15–34 is higher, predictably, than the national average, at 38.2%. What this means is that more than one in every three young people available for the labour force did not have employment when the survey was undertaken in 2018. Of the 10.3 million aged 15–24 years, approximately 3.3 million (or 32.4%) were either unemployed, or not in education or training. Although the *not in education, employment or training* (NEET) rate declined among young black African and coloured males, it increased among Indian, Asian and white males. Among females, the NEET rate increased for the three population groups with the exception of young coloured females. This group of unemployed and disengaged youths is what Cloete (2009: 15) terms the 'social time bomb' of youth and, as they are unemployed and not in education or training, it is unclear what will effect a change to their status. Cloete and Sheppard in 2009 put this figure conservatively at 2.8 million which appears by 2018 to have increased to 3,3 million. The NEET rate in conjunction with the overall unemployment rate suggests that the youth face extreme difficulties engaging with the labour market or accessing any means (let alone HE) through which to effect changes. The youth accounts therefore for 63.5% of the total number of unemployed persons and, of direct relevance to any discussion of HE, the rate remains higher *irrespective of the level of education*. In effect, just over 30% of the youth has employment and only half participate in the labour market. It is the 15–24 year olds who are the most vulnerable in the labour market with an unemployment rate of over 52%, and an absorption rate of about 12.2%. Labour force participation rates in this group are 25.6% (Stats SA, 2018b).

Given the assumed link between higher education and employment indicated above, what does this mean for post-school education, and specifically for higher education? Is it possible to create employable graduates through 'the planned learning opportunities offered to learners by the educational institution and the experiences learners encounter when the curriculum is implemented'? (Print, 1987: 4). Given that employment rates do not differ significantly based on education levels, is it possible that there are things not taught that must be taught, and that the current qualification types and programme options have been removed from the education offered to students in this insistence on the link between jobs and education? An examination of the skill set required for the Fourth Industrial Revolution shows that it is not an entirely new set (see Diagram 1 below) and that some, if not all, of the skills required may be timeless, as is the fact that the future is unknown.

It is argued in this paper that what needs to change is how the development of skills may be achieved through curricula that are designed to enable learning and how these skills may be appropriated for multiple uses, flexibly, and readily extrapolated to diverse, future, and perhaps even unknown, contexts. The current regulatory framework (DHET, CHE and SAQA) view of learning programmes and curricula is teleological in its approach to skills, and assumes that the programme design principles encapsulated in the framework will lead to a programme of worth. The Accreditation Criteria set the minimum 'threshold standards' for the delivery of HE, the HEQSF determines both the naming and structure of all qualification types, the SAQA level descriptors establish whether the outcomes are at the correct level, and SAQA policy determines the manner of assessment and phrasing of the Associated Assessment Criteria, and the DHET documents ensure alignment to funded CESMs. Add to this the development of programme-specific requirements (qualification standards) which include 'graduate attributes' in addition to the above

requirements, and the result is a compliance-heavy, ponderous system with little inherent flexibility and almost no room for experimentation. This compliance-heavy system, coupled with the assumption that education means skills which correlate to programme 'outcomes' at a certain, defined level, means that a thorough reversal or re-imagination of the nature and form of higher education may be needed to prime the system for the 4IR and make a discernible impact on the employability of students in the system.

This article looks at the context in which programmes are designed and approved in South Africa, and argues that the agility and responsiveness of universities must be liberated from the current technocratic and bureaucratic conceptions of higher education as reflected in the various regulatory and quality documents, requirements and processes. A somersaulting of curriculum constructs is essential to rethink the knowledge packages or bundles and a more empowering pedagogy in line with our age of 4IR. Ramrathan (2016: 8) argues that curriculum transformation in SA has been largely instrumentalist and that 'deep curriculum intellectualism' is required. Le Grange (2016: 7) alludes to the 'factory model' of curriculum with outcomes stated and an accompanying assumption that a statement of outcomes equates to achievement of these in a mechanistic form. It is argued that a shift from mechanistic instrumentalist approaches is required.

WHAT IS EDUCATION FOR THE FOURTH INDUSTRIAL REVOLUTION?

Max Nikias (2016) refers to the 4IR as prompting a response from universities for a world in which 'technology will develop exponentially, blurring the lines between the physical, digital, and biological spheres' (Max Nikias, 2016). Designing curricula to serve these ends is not, however, supported in the current dispensation with its focus on predefined categories of learning (set out in the Classification of Educational Subject Matter, hereafter referred to as the CESM document), and unchanged since 2009; and the need to obtain prior DHET approval for a programme, or an additional CESM, and then accreditation by the CHE and registration on the NQF by SAQA (2000), a process that takes upwards of 18 months to as long as 30 months.

Likewise, the insidious creep of technology into all aspects of teaching and learning over the last 20 years has still not been addressed by the regulators and policy-makers. Often, creative approaches to the uses of technology are seen as undermining education or signalling a downward spiral in quality rather than facilitating it. The move from the physical blackboard, to PowerPoint, to podcasts and videos, to interactive online platforms, clickers and twitter in the classroom has not been matched by an equivalent flexibility in the processes and policies designed to ensure quality in higher education. In fact, the duality of the modes of delivery as provided for by the regulatory bodies also does not reflect the current realities of the delivery of HE, let alone those of the future. Ironically, it is these regulatory measures ostensibly designed to assure the system of quality that are responsible, at least in part, for rendering qualifications rapidly outdated, and institutions increasingly frustrated in their attempts to respond speedily and effectively to the trends identified (which is backward facing) and anticipated (which is future facing). In addition, the existing framework propagates an associated model of teaching and learning, implicit in all the framework documents including policies and criteria (CHE, 2004). If universities are to respond to the 4IR demands (and also to the employment needs of the youth), then these inherited, static regulatory and academic tools need to be rapidly and effectively broken down so that new ways of teaching and learning, new curricula and programmes may be devised, tested, changed, and redesigned, as needed. It must also be noted that not all of these will be HE responses, nor will they all be qualifications. The notion of the 'ivory tower' university, working on its own with its own students may too have to be challenged, as different universities offer up their strengths in collaborative rather than competitive ways to address the wide range of needs across the sector, from entry-level skills to high-level research production initiatives.

The agility needed in the sector to respond to the rapidly changing needs of the employment sector, student demands, learning and knowledge flexibility, inter-, trans- and multidisciplinary responsibility, is

currently not supported by the framework in which HE operates in SA. The strong 'gatekeeping' function of the regulatory framework means that the heavily inspectorial approach at the front-end of the design process inhibits the agility with which institutions are able to produce 'graduates' at the end of the process. There is critical consensus in the literature on the developmental state (Evans, 1995; Evans, Huber & Stephens, 2014). In this state, well-capacitated bureaucracies are critical for development. Although a constant discussion point in many HE forums across the country, little direct attention has been paid to the extent to which bureaucratic processes in the South African context serve to reduce the speed and agility of the responsiveness of universities. It is acknowledged that the DHET, CHE and SAQA are important vehicles in transformation as specified in their mandates; however, what is argued is that there should be new ways of permitting for new programmes to be delivered so that the system is able to recognise and acknowledge, adapt and respond to emerging institutional demands and policy imperatives.

Continuous adjustments to an outdated and inflexible system will not adequately address the seismic shifts that have affected not only the way the economy is constituted, but also the ways in which people now work, and even more importantly, the demands students place on education and their expectations of its achievements. Added to this is the fact that South African institutions of higher learning face the concept of the 'lag' between the developments in the economies with which the country continues to engage, and the entry and departure points in these. If SA is not always to be in 'catch-up' mode, it will be necessary to urgently and aggressively meet the demands of the 4IR in ways that directly and coherently impact on the curricula offered to students such that dramatic and radical changes to their learning and interactions with the world are effected. The changes required are, often, in manner rather than category. Thus, for example, the skills required for computing numbers are still important. However, the manner in which these are applied has changed. The kind of problem solving users have access to when software can compute more speedily and more readily what can be achieved manually, liberates the thinking person from manipulating the numbers to redesigning the perceived problems, and designing new responses to which the numbers, the software and so on are all simply aspects of the arsenal of tools used to reach solutions. In the 4IR, the problem will be with 'finding people with the right mix of skills: the data scientists who combine technical skills, analytical and industry knowledge, and the business sense and soft skills to turn data into value for employers' (Mateos-Garcia, Bakhshi & Windsor, 2015: 37). The link established by the current framework – in other words that a particular qualification or programme (and by extension the curriculum) leads to a particular skill set which is then de facto linked to a job or occupation has failed to produce the graduates that were envisaged and the employment that was its stated focus. What it has done is it has produced a plethora of programmes that focus on content rather than skills. For example, a Bachelor of Arts degree which was the primary vehicle through which students learnt to read and think and write, has now become a Bachelor of Arts in Public Relations, and a Bachelor of Arts in Communication, and so on. The same has happened to most undergraduate Bachelor's degrees with increasing areas of specialisation reflected in the content, rather than in the skills. Given that (a) these increasingly limited degrees have not had the impact that they were intended to have on employability, and (b) that the jobs of the future are unknown, and (c) in light of the fact that aspects of the skill set are the same, it is no longer possible to assume a linear relationship between the programme/qualification type and level and an occupation. It seems illogical to constrain the types of qualifications and curricula insisted on in the regulatory processes based on what is not known now, rather than on what is known, which is the move that has taken place from skills to content in the increasingly specialised focus implicit in the current accreditation and standards framework. As can be seen from the diagram below, it is the skills that were needed before that are needed for the future:

Diagram 1: Skills for the 4IR
WEF, 2016.

2015									
Complex problem solving	Coordinating with others	People management	Critical thinking	Negotiation	Quality control	Service orientation	Judgement and decision making	Active listening	Creativity

2020									
Complex problem solving	Critical thinking	Creativity	People management	Coordinating with others	Emotional intelligence	Judgement and decision making	Service Orientation	Negotiation	Cognitive flexibility

It is the focus on these skills that has been lost in the current framework and in the current emphasis on compliance with the qualification types and the resulting 'sameness' across all institutions, and all institutional types. What is needed is a clear and distinct step away from the current approach to degrees as binary categories (either professional or academic; undergraduate or postgraduate; research-led, or work-led), or as knowledge silos (either Science or Humanities; Commerce or Education), into skills- and knowledge-based matrices in which students can insert themselves as sentient learners capable of defining the areas in which they need to develop new and enhance existing skills, attributes, attitudes and values. The McKinsey Report on Disruptive Technologies (Manyika et al., 2013: 15) states clearly that '[t]he nature of work will change, and millions of people will require new skills'. It may not be the case that the skills that are needed are new, but rather that new conceptualisations of qualifications are needed from which basis the skills may be acquired. The challenge for universities then is to be able to transform their curricula, their teaching and learning strategies, their pedagogical approaches and the very assumptions on which curriculum design is currently embedded. These assumptions include a strong focus on the deficit model, a content-driven understanding of knowledge, and narrow and constraining assessment modules and requirements. There is no question that it is necessary to move from the current deficit model, which relies on the outcome statements and the content and 'skills' needed to 'fill' these deficits, and which is circumscribed by conventional teaching and learning engagements, and assessment models, into a more dynamic and systemic approach to how to 'do' higher education. In some sense, a return to the notion of learning for the sake of learning is needed: it does not fundamentally matter what is learnt, it is far more important that it be learnt in ways that enable and empower students to continue to learn and adapt to new ways of being and doing with or without the presence of the 'learned professor'. It must be noted at this point that this is not all about a focus on technology and robots and what these tools can do for us. The 4IR is about people and their interactions with each other, and the ways in which these interactions can solve social, economic and other problems. To this end, the South African economic context is supremely relevant.

HIGHER EDUCATION'S RESPONSE?

An interrogation of programmes, qualifications and 'curricula' across all levels of learning is required if South African HE is to effect the changes that are and will be heralded by the 4IR. No level or discipline of learning can be excluded from this view; and if this requires transforming the entirety of the education sector, it is the universities that will play a crucial role in its reconfiguration. By way of example, Singapore recently adopted a three-pronged strategy (Gleason, 2018) designed to achieve its strategic goals. In this approach, they decided to do the following:

1. Deepen and diversify international connections.
2. Acquire and utilise deep skills.
3. Build strong digital capabilities.

Clearly these will not be the same as those required by South Africa, and if the country has learnt anything at all from the experiences since 1997, it must be this: SA cannot mimic what has worked (or has not worked) in other countries and hope that it will work here (Cross, Mungadi & Rouhani, 2002), much as was done with Outcomes Based Education (Allais, 2003). It is necessary to respond to the challenges posed by the 4IR in a manner that is able to encompass both SA's unique history, its complex present, and the potentially explosive needs of its future. The inclusion of the Singapore example is not intended as a transferable template for SA, but as an example of what will be needed as a strategy for SA to address the persistent inequities in its education system. The Singaporean example provides a basis to demonstrate how other university systems have reimagined curricula.

Gleason (2018) advocates the use of a problem-solving approach highlighting 'problem-based learning with an authentic outcome is the mode of education' (2018: 148-149), and cautions against the replication of the Singapore model without interrogation of the context. For example, the replacement of jobs through automation could have dire consequences for SA where unemployment rates are already socially and economically compromising. The suggestion by Gleason is that 'there are exciting opportunities to leapfrog more advanced economies that will be locked into brick and mortar solutions and tied down by bureaucratic legacies' (2018: 165). According to Xing, Marwala and Marwala (2018: 197), 'the future economic growth and competitiveness of a country largely depend on its innovation capacity, which is mainly sourced from the new knowledge and trained graduates produced by universities'.

In the South African context, this may mean that there is a need to shift the current policy discourse from its almost singular focus on STEM education to a more all-encompassing approach to revisiting curricula and teaching and learning pedagogies so that it is possible to find approaches that result in SA HE 'deploying pedagogy that yields creative thinkers with practical skills' (Xing et al., 2018: 200). Barr and Tagg (1995) argue that the changing role and purpose of higher education is 'not to transfer knowledge but to create environments and experiences that bring students to discover and construct knowledge for themselves, to make students members of communities of learners that make discoveries and solve problems' (1995: 5). On this matter, Bawa (2017) is clear: there is a need to review the nature of our curricula and assess whether and to what extent they connect with what is likely to be the world of work in 2035, in as much as it is possible to imagine this. Additionally, there is a need to actively consider the potential emergence of new professional careers, some linked to the technological developments likely in the 4IR, and others related to the development and support of the new conceptual frameworks needed as these technologies lead to new human-technology interfaces in society (Bawa, 2017).

There is, however, a difficulty: while a complete review of the current educational system with all its regulatory, policy and compliance aspects will require time, the changes in the environment are occurring rapidly. Against this background, it can be argued that Bawa's (2017) position does not go far enough in rethinking programmes and curricula. If HE is to prepare students for the challenges of the 4IR, a more rigorous engagement is required by all academics across the board – cutting through silos – innovative pedagogies that enable students to become independent learners outside of the confines of the lecture halls. Conventionally, the face-to-face mode of delivery in higher education is premised, however lightly, on a dependence paradigm of learning: the teaching, provision of readings, lectures, focus on the achievement of outcomes, assessment related to content and reliance on the expert are in the hands of the academic staff member. As students progress through the qualification, the dependency is incrementally reduced resulting, at least theoretically, in independence. This model is explicit in the SAQA level descriptors

(SAQA, 2012), as well as in the typology of qualifications in the Higher Education Qualification Sub-Framework (HEQSF) (CHE, 2013). The assumption of this model is that everyone is on a continuum which begins in higher education with a level 5 and ends at a PhD, and is part of the problem. Progression is defined vertically. It may very well be the case that a more 'shotgun approach' is needed: universities can cater for people learning what they need, to when they need to, and still have a framing qualification. The 4IR demands not just an intervention in the process described above, but a rejection of the static model and a shift to the emancipated learner. In line with what Gleason (2018) says, students need to be able to engage with the real world while problem-solving of a complex kind, mixed with the flexible and creative skills needed to continuously learn and respond to change. Broadbent (2018) argued that

> in the world that is becoming, there are no trades. There are just problems to be solved, opportunities to be taken advantage of and to disrupt: to be critically evaluated, and then to be ignited by an idea that strikes the status quo like a bolt from the blue. A university education that equips graduates for this reality is crucial

The current SA qualification mix may contain a few qualifications designed to achieve just this; however, it is certainly not the case that these are easily found.

Kant and Schiller, at the forefront of the Enlightenment, argued for the development of critical thinkers. This necessitated

> the subject learns the rules of thought, not a content of positive knowledge, so that thought and knowledge acquisition become a freely autonomous activity, part of the subject.... What is thus taught is not facts but critique, the formal art of the use of mental powers, the process of judgment (Readings, 1996: 67).

Readings further argues that the modern university began to be defined by curriculum related to the public good as determined by the political context. The rise of the corporate university and achievement of excellence measured by performance indicators, is what was termed as the ruins of the university. The 21st century has propelled universities into further chronic uncertainty as to what the future will hold and what the implications are to prime up for the 4IR. It could be argued that in a sense, universities revert to the Kantian notion of the development of critical thinkers. The question is whether universities are able to change in terms of pedagogy and curricula in producing graduates for the 4IR which requires a broader skills set unlike the model of intensive specialisation that has dominated the qualifications field. Can this be achieved through the traditional university and the bureaucratic systems that govern teaching and learning? Possibly not. Shifting a paradigm may be too gentle a conception of what is required. There is a need for an aggressive disruption of current thinking, existing methods and processes, if HE and universities are to achieve real change to the way in which teaching and learning pedagogies are framed. Change of the entire academic governance processes is needed: both the superstructure and the substructure. The substructure in this case is the regulatory framework within which higher education is bound. Just as in economics, it is the base that establishes the parameters for performance. In its attempt to transform, the policy and regulatory framework runs the risk of stultifying and ossifying. The reductive consequence – unintended as it may have been – means that this base has resulted in a range of qualifications that are tied to characteristics not designed to liberate, but to proscribe. The way in which South African higher education now stands in relation to students, to staff, to disciplines, to knowledge, and to ideas has been determined by this base, with few attempts to avoid or subvert this. The superstructure, or how each institution has given or tries to give effect to its specific culture, to its particular understanding of power, of academic freedom, or of autonomy, to its perceived role in society and relationship to the state is over determined by a set of policies not abreast with contemporary thinking and the need for reactiveness, for responsiveness.

CONCLUSION

South Africa remains a deeply stratified society, especially technologically, and certainly economically. Nonetheless, it may not be too late to make the leap needed from the current paradigm to a new one in which less regulation and fewer compliance-driven activities permit for the transformative programmes and curricula needed to ensure that students are empowered participants in the construction of their own learning pathways and the achievement of their goals. As a society, South Africa remains convinced (and most HEIs' marketing strategies confirm this), that a degree is, if not the only way, then certainly the 'best' way, to a future. If students are not treated as objects of the learning programmes and curricula then they may be engaged fully as active participants of equal value in the creation of their own learning (Biggs & Tang, 2007: 21). In such an approach, they will have to assume responsibility. The changes to programme and curricula aside (and these are not minor), the greater challenge will be to create a space in which the new programmes and curricula may be delivered and explored using new approaches to teaching and learning. Interactions between the regulators, institutions, academics and students are needed to develop active relationships in which learning and developing are the result for all three participants, even if not to the same extent. In conclusion, the value of a transformative education lies in its ability to move with the differences among students and their interests, with differing conceptions of what constitutes a valid curriculum and a valid assessment, and, in line with the 4IR, to an approach that challenges lecturers, students and institutions alike with modes of assessment tailored to the achievement of new modes of teaching and learning.

It is clear that the vehicle of qualifications as prescribed by the HEQSF (CHE, 2013) and as regulated by the CHE, is not the appropriate vehicle for responding to the needs of the immediate future, given the rigidity that exists in defining the qualifications, and the ever-increasing detail in the standards issued. Universities are required to actively engage with teaching and learning spaces looking forward as opposed to a historic building of curriculum, teaching and learning practices (Barnett & Coate, 2005). It may very well be that what is required is a 'Marshall plan', appropriating strategy from the military as advocated by Sun Tzu. What this suggests is the need for quick responses to changing conditions and dealing with the unexpected with agility.

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