Clouds, Codes, Data and Digits: Alternative Realities in Virtual Worlds?

South Africa's use of Clouds, Codes, Data and Digits for national development[1]

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INTRODUCTION

Like most nations on earth, South Africa exists in a "Digital World", a term that defies most attempts to define it. This attempt to understand "Digital Worlds" follows the mighty "digital giant" Microsoft's attempted definition of the term in the company's online lecture "What is a Digital World?", and from this (still) undefinable concept, follow Microsoft's focus on the "Professional Digital Worlds" for which we aspire, using "Learning Digital Worlds" as an alternative to learning about our wondrous, albeit troubled, very analogue world, with all its unparalleled "unpixellated" physical beauty. This very "*Analogue World*", sustained human evolution for millions of years before we began to digitize it. The pixels, millions of tiny multicoloured lights about one quarter of a millimetre in size, can be used to share the beauty of our analogue world with all who live in it, on their 4K or lessor TV screens, their cheap or very costly mobile "smart" telephones, their laptops and computers which often cost the equivalent of a lifetime's income for some. The Digital World can help us to share Leonardo DaVinci's genius, his Mona Lisa, across 500 years of creativity, to all 8 billion multilingual world citizens alive today. And yet, no amount of digitization, or its marketing equivalent "digitalization', can capture the genius of the artist, most certainly not in "digital clouds". Yes, the "Digital Cloud" is an important imaginary place into which Microsoft ascended on its AZURE public cloud computing platform, in which the company's current CEO exists - "*I Won't Exist if I'm not in the Cloud*" (dictionary definition of AZURE - the unclouded sky – translation: an empty place?).

Pixel – A Layperson's explanation: Cambridge Dictionary: "*The smallest unit of an image on a television or computer screen*". Example: If you want to "digitize" Leonardo DaVinci's artistic masterpiece, the Mona Lisa, insured for US$900 million in 2021, please use a copy - the original, created more than 500 years ago, is far too valuable. The exquisite analogue (i.e., not digital) eye/hand/brush/paint/canvas/***mind*** coordination by the artist, the many nuances that suggest the artists mood fluctuations as he painted, are far too complex to be captured by the current average of about 8,294,400 dots of multi-coloured lights - pixels – which are used to translate digital images back to their analogue glories. A digital copy of the Mona Lisa can/has been created and distributed worldwide, but what value can a digitally created work of art have, with or without the assistance of artificially intelligent digits, compared to the meticulous analogue creations by living human artists? Can the music of John Coltrane or Ludwig van Beethoven, or the spontaneous improvisations of the musical giant Louis "Satchel-mouth" Armstrong which changed the whole world of musical art, be created in digits?

The world is analogue, its visual beauty can be pixelated or digitized to any level we may use to spread the good news, but the original can never be digital. "*Full many a flower is born to blush unseen; And waste its sweetness on the desert air*" – seen or unseen by human eyes, Thomas Gray's imagery of a blushing desert flower can never be digitized, even if his poetry can (*Elegy Written in a Country Churchyard*).

This discussion begins with an examination of South Africa's "Learning Digital Worlds" – the nation's major "Achilles Heel" - a vulnerable point, a weakness that could do irreparable damage to the country, one which inhibits the nation's sustainable development and wellbeing through education and learning. The knowledge for all, gained only through sustained lifelong learning, is directly related to all human and environmental challenges as defined in the seventeen Sustainable Development Goals (SDG). These challenges include the alarming statistic that South Africa is the world's socioeconomic inequality leader (e.g., World Bank, March 2022), and tragically for the nation's future growth with social stability, the world's leader in youth unemployment (STATS SA 2022).

South Africa's education and learning vulnerabilities are illustrated by statistics compiled and published by South African state entities and all their multisectoral development partners. South Africa's learners on average rank amongst the lowest achievers in the world – 36% below the global average in reading (PIRLS 2016); 25% and 35% below global averages in the most recent 2019 TIMSS

math and science international assessments, and by the extremely high dropout rates throughout the education and learning process.

Learning deficiencies and consequential knowledge inequalities are the primary cause of South Africa's high unemployment rates and poverty headcounts, the latter ranking the country 43rd out of 45 nations listed in the World Bank's Upper-middle-income classification. High levels of inequality, poverty and unemployment are well-known triggers of socio-political upheavals like the regular xenophobic violent outbreaks, the Marikana Massacre, the July 2021 looting and violence, and of course the continuous tragic abuse of women and children, and many more.

The ICTs, and all their electronic and pre-electronic predecessors, have always been known to be the most effective means of sharing and spreading information and knowledge over distances beyond human speech, hearing, feeling, seeing, and therefore knowing limitations. How has South Africa used this vital ICT tool for its human and national development? The statistical reality is that just 24% of the nation's estimated 24,894 schools in the country, 6,085 schools in total, were connected to the "Digital World" through the internet in 2021 (2022 State of the ICT Sector Report). An alternative report by the Department of Basic Education (NEIMS 2019) reports that of 23,258 "Ordinary Operational Schools", only 20% had internet connections for teaching and learning, whereas 29% of the total had internet connections for administrative purposes only. Of even greater concern is home connectivity – the ability for children and whole families to learn together, at home. In 2020, just 8.3% of South Africa's households had 24/7 internet connections at home, down from a peak of 10.9% in 2014 (source: ICASA and STATS SA reports for 2020 and previous years). The average fixed broadband penetration, a proxy for household broadband penetration, was just 2.19 per 100 people in 2020, compared to an average of 26.6 per 100 for all equivalent upper-middle-income countries, source World Bank 2020.

In this still emerging digital world, "clouds" have become central to its existence and growth. South Africa demonstrates this "cloud" centricity through the launch of the "Proposed National Data and Cloud Policy" by the Minister of Communications and Digital Technologies (DCDT) in April 2021. The draft policy received numerous, mainly critical responses, through its invitation for written submissions. This discussion is not about the content or merits of the draft policy, or the written criticisms and/or supporting submissions it generated, these are freely available online through a simple "digital world" search. This discussion is an examination of the underlying concepts – clouds, data, and digits. A simple word search of the draft policy returns 65 references to "cloud", 401 uses of "data", and 171 uses of the word "digital". Each of these central concepts are examined briefly, their historical, scientific, and common usage origins, their transitions into today's lexicons, and their value in South Africa's quest for knowledge through technologically assisted education and learning. Technology assisted education and learning must aim at redeeming the nation's humanity, through reduction of all underlying national challenges described in the seventeen Sustainable Development Goals (SDG), and in the nation's own seemingly moribund National Development Plan (NDP).

CLOUDS:

1. Dictionary definitions:

   (a) Cambridge Dictionary: (i) a grey or white mass in the sky, made up of very small floating drops of water; (ii) a mass of something such as dust or smoke that looks like a cloud.

   (b) Collins: (i) A cloud is a mass of water vapour that floats in the sky. Clouds are usually white or grey in colour; (ii) A cloud of something such as smoke or dust is a mass of it floating in the air; (iii) Verb: *if something "clouds" your view, you are unable to understand it or judge it properly*; (iv) *if something "clouds" a situation, it makes it unpleasant – your eyes or face "clouds over" in sadness or anger*.

   (c) Merriam Webster: (i) a visible mass of particles of condensed vapor (such as water or ice) suspended in the atmosphere of a planet (such as the earth) or moon; (ii) a light filmy, puffy,

or billowy mass seeming to float in the air; (iii) a usually visible mass of minute particles suspended in the air or a gas; (iv) *something that has a dark, lowering, or threatening aspect*; (v) *something that obscures or blemishes.*

2. Origin of Clouds:

   (a) **From National Geographic** June 2022: Astronomy, Chemistry, Earth Science, Geology, for learners in grades 3 to 12: https://education.nationalgeographic.org/resource/formation-earth: "Our planet began as part of a *cloud of dust and gas*. It has evolved into our home, which has an abundance of rocky landscapes, an atmosphere that supports life, and oceans filled with mysteries. We live on Earth's hard, rocky surface, breathe the air that surrounds the planet, drink the water that falls from the sky, and eat the food that grows in the soil". Read more

   (b) **From CERN – home of the Large Hadron Collider – the world's leading edge of scientific discovery**: https://home.cern/science/physics/early-universe: Origins: "In the first moments after the Big Bang, approximately 13.7 billion years ago, the universe was extremely hot and dense. As the universe cooled, conditions became just right to give rise to the building blocks of matter – the quarks and electrons of which we are all made. A few millionths of a second later, quarks aggregated to produce protons and neutrons. Within minutes, these protons and neutrons combined into nuclei. As the universe continued to expand and cool, things began to happen more slowly. It took 380,000 years for electrons to be trapped in orbits around nuclei, forming the first atoms. These were mainly helium and hydrogen, which are still by far the most abundant elements in the universe. Present observations suggest that the first stars formed from *clouds of gas* around 150–200 million years after the Big Bang. Heavier atoms such as carbon, oxygen and iron, have since been continuously produced in the hearts of stars and catapulted throughout the universe in spectacular stellar explosions called supernovae". Read the whole article here.

3. What we know about real clouds:

   a. The sun shines on masses of water, the earth's oceans, seas and lakes, heating the surface water and generating steam, which rises into the atmosphere, to form the clouds that we see so regularly above us;

   b. The "steam" cools, forming "clouds" of water vapour, which in turn combines into water droplets, falling to earth as rain, redistributing the earth's water resources and providing the gift of life to all on earth. Without these water redistributing clouds, destructive draughts occur, destroying much of life in their paths. With too much water in the clouds, destructive floods occur, destroying much of life and human infrastructure in their paths. These cycles are vital STEM knowledge, directly associated with climate change science, the leading existential threat in these times of great change;

   c. As the wind blows the water droplets around, they rub against each other, generating static electricity, which accumulates to billions of volts, discharging as powerful lightning strikes, "fixating" atmospheric nitrogen in its path, which falls to earth as the vital nitrogenous fertilizers that life needs;

   d. The lightning bolts also cause tremendous damage through their immense power, but scientific humans have understood the process, and found ways of reducing the damage – vital knowledge about the various types of clouds - cumulus, cirrus, stratus and nimbus, etc. The energy generated by each cloud type, its response in different kinds of soil – different soils have different electrical resistance properties – have taught humanity how to divert the destructive electrical energy from the most welcome clouds into the earth, bypassing and protecting human life and its infrastructures. All these are components of the STEM subjects that most South African children, youth and adults find so difficult to understand. Knowing

about the STEM and all directly related branches of science, including the humanities, will go a long way towards improving the lives of up to 65% of the nation's children, all of whom are exposed to stifled brain development through living in poverty (discussions on page 3 of ICT4SDG4).

4. Cloud Computers: Definitions:

a. Microsoft: a.k.a. "Azure", Cloud Computing Services: Simply put, cloud computing is the delivery of computing services—including servers, storage, databases, networking, software, analytics, and intelligence—over the *Internet ("the cloud")* to offer faster innovation, flexible resources, and economies of scale. You typically pay only for cloud services you use, helping lower your operating costs, run your infrastructure more efficiently and scale as your business needs change.

Is the Internet now obsolete, replaced by *"the cloud"*? What about the invaluable actual use of this internet, cloud, internet cloud, whatever, for the distribution and sharing of the information and knowledge required by humankind?

b. Investopedia, 23 June 2022**:** "*Cloud computing is the delivery of different services through the Internet. These resources include tools and applications like data storage, servers, databases, networking, and software*". Has "cloud computing" replaced, or superseded the internet in importance and value as an information and knowledge-sharing infrastructure in SDG9 and SDG17?

c. IBM, 18 August 2020: Cloud computing is on-demand access, via the internet, to computing resources—applications, servers (physical servers and virtual servers), data storage, development tools, networking capabilities, and more—hosted at a remote data center managed by a cloud services provider (or CSP). The CSP makes these resources available for a monthly subscription fee or bills them according to usage.

Is this CSP just a "middleman"? Could he/she be located in/on a cloud, receiving orders for the listed services via the internet, and delivering the required services from the cloud via the internet? Yes, even IBM's "virtual servers" are very real – consisting of metal and plastic housing, massive digitally-encodable microchips, and programmable software. They are moving rapidly towards quantum and biological computing devices and networks, which are also physically very real. They cannot be located in clouds under any circumstances.

d. TechCrawlr: **A classic definition**: "*The major difference* (between the internet and cloud computing) *is that the internet is a network of networks that provides an infrastructure that creates and maintains the connectivity of computers worldwide while Cloud computing is an internet service that offers various kinds of resources over the internet".* Of course!!!

The Collins Dictionary definition of "cloud" comes to mind from the above definitions: "*(iii) if something "clouds" your view, you are unable to understand it or judge it properly; (iv) if something "clouds" a situation, it makes it unpleasant – your eyes or face "clouds over" in sadness or anger*";

And Merriam Webster's definition: *"(iv) something that has a dark, lowering, or threatening aspect; (v) something that obscures or blemishes"*

Alternative Facts and Falsehoods about the vital ICT sector tend to meet the Collins and Merriam Webster definitions.

All the above factual science about clouds is available for South Africa's children and youth to learn. It can be as simple as the short narratives above. But why do the children and youth of South Africa do so badly in the critical STEM subjects that define this science and its practical life-saving and life-

supporting applications? Could it be that we are "mis-educating" our children and youth? "Mis-leading" them with bad or nonsensical science and non-engineering, all of which positions computers, servers, vital wireless and fixed telecommunication infrastructure, inside clouds? If the engineers and scientists of today were able to "invent" antigravitational technologies that prevent vital ICT infrastructures from falling out of the clouds and shattering on mother earth, or being damaged by the damp million volt charged atmosphere in the clouds, only then would "cloud computing" be of any value.

The nonsensical science of "cloud computing" and similar meaningless hype is deeply entrenched in the global technological psyche. It is fuelled by high financial profits earned through fashionable marketing misinformation and the gizmos that arise from it. It is aided and abetted even by the vital well-intentioned technological advances of the 4IR, the full range of self-learning AI technologies driving robots and botnets, which also enable malicious algorithms that cause harm to humans and the technologies they depend on, either intentionally or inadvertently.

South Africa cannot change the digital world and its very popular cloud-based obfuscations. The nation's children and youth will encounter these distractions as they grow older, whatever they may learn in their formative years. The only recourse for South Africa is to effectively impart the full spectrum of factual scientific knowledge to them in their early brain formative years, especially the ability for critical and rational thinking. This will enable the adults of tomorrow to recognise all the alternative or fake sciences and their media marketing, promotion, and hype, and be ready to protect themselves and their communities from it all. The children of tomorrow will need to acquire the capability to learn the right kind of knowledge, and be able to "unlearn" the alternative or fake knowledge they will encounter as adults.

The New World of Digits

Digital computer engineering techniques began more than 200 years ago with Charles Babbage's Difference Engine. Charles Babbage's creation was followed about 80 years ago by the construction of perhaps the first digital electronic computer, the Colossus, a programable calculating machine weighing 5 tonnes and consuming 8.5 kilowatts of electrical energy. The Colossus was designed to break Germany's "Enigma" secret code that did so much damage to the world's armed forces resisting the onslaught of Nazism. The tragic genius Alan Turing designed the Enigma code-breaking algorithms and operational computer programmes that saved the western world from a disastrous defeat by Nazi Germany. Alan Turing was very badly rewarded for his genius – effectively murdered in 1954 by his own government, a punishment for his sexual preferences.

5. The Internet: A vital Telecommunication Component:

Central to the concept of the "Digital World" is the Internet, or perhaps its most modern iteration or transformation to "the Cloud". The most popular and easily accessible laymen's reference source, Wikipedia, defines the "Internet", or is it "the Cloud", as:

> **The Internet (or internet)**[a] is the global system of interconnected computer networks that uses the Internet protocol suite (TCP/IP)[b] to communicate between networks and devices. It is a *network of networks* that consists of private, public, academic, business, and government networks of local to global scope, linked by a broad array of electronic, wireless, and optical networking technologies. The Internet carries a vast range of information resources and services, such as the inter-linked hypertext documents and applications of the World Wide Web (WWW), electronic mail, telephony, and file sharing.

Most definitions available today have recognised that something very important is missing from this definition – people. It has always been a mystery why computers would want to be interconnected through "computer networks", irrespective of the interconnection protocols or the physical interconnecting infrastructures. One of the founding fathers of today's internet, or is it the cloud, Dr Joseph Carl Robnett "Lick" Licklider, pleaded with the world and all its computer and technological

gurus to keep this very human tool, out of the hands of computer geeks (Source: http://www.columbia.edu/~rh120/ch106.x07):

"*It is not proper to think of networks as connecting computers. Rather, they connect people using computers to mediate. The great success of the Internet is not technical, but in human impact*"

South Africans as a whole, the bureaucrats, the technocrats, and most ICT users, seem to be held in awe by the digits that drive today's very efficient technologies of telecommunications, e.g., the National Government mantra "Go Digital South Africa", the Digital Dzonga Council appointed in 2008 to rapidly steer the migration of analogue television to "Digital Terrestrial Television". The Digital Dzonga Council was officially dissolved in April 2010, while the international deadline for this migration, 17 June 2015, was missed by a wide margin, and has yet to be realised in 2022.

Perhaps South Africa would have been more successful if the nation's decision-makers, both in government and in the private sector, had focussed on the desired end results – access to, and productive use, of ALL ICTs by ALL South Africans, instead of holding a blind faith in digits as the saving grace for the nation's multidimensional growth challenges.

Digital Technology is a very simple engineering masterpiece, easily learned by even the youngest citizens provided they are allowed to learn about this simplicity. In a nutshell, digital technologies are based on the simple engineering practice of breaking up complex linear hard to manage analogue electrical signals into billions of on-off electrical pulses, and coding these pulses to represent the original analogue signals. The coded digital pulses are then transported to their desired destinations where they are decoded back to their pristine analogue formats. The digitization process led to very simple engineering architectures, which allowed massive miniaturization, which in turn led to very large-scale integration into microminiature integrated circuits which contributed towards the development of the technologies of the 4IR. A typical transistor switch today can be smaller than two nanometres – the average diameter of a human hair is 50,000 nanometres, 25,000 times bigger.

Digital Technologies are simply a means to the end of progressively powerful telecommunications, the final defeat of distance as a barrier to information and knowledge sharing. This successful use of the simple digital engineering feat enabled the design and operation of the James Webb Space Telescope, located more than 1.5 million kilometres from the earth's surface, able to capture images of long dead stars, planets and galaxies, and transmit these incredible images back to earthly bound laboratories 1.5 million km away. The underlying principles of the James Webb telescope are relatively simple, its construction, launch and operation were extremely complex, but well within the capability of humans who understood the simplicity of both analogue and digital technologies, and overcame the complexity of using them.

Digital technologies can, must, be applied similarly to defeat the very complex human challenges of ignorance, which inexorably lead to inequality, poverty, unemployment, and all interdependent SDG challenges that plague the country.

There are no such things as "Digital Worlds", "Digital Universes", "Digital social threats", etc. There are nearly infinite ways to use digital technologies to overcome these threats to humanity and its living environment.

Data:

Closely related to digits, clouds, and coding is the often-misunderstood world of data.

Definitions:

(a) The Oxford Dictionary provides an elegant definition of "data": "*facts or information, especially when examined and used to find out things or to make decisions*".

(b) The OECD defines "data" as: "*Characteristics or information, usually numerical, that are collected through observation"*.

(c) Britannica Dictionary: (1) "*facts or information used usually to calculate, analyse, or plan something"*; (2) "*information that is produced or stored by a computer*"

Based on the most popular definitions, data comprises any and all forms of information, be it aural, written, numeric, or even visual. Data is therefore as broad in meaning as its creators and users would like. Data can be represented by digits, to ease its manipulation, processing, storage and distribution in computers and interlinking telecommunications networks (the internet is a telecommunication). Artists produce artistic data, often following many years of study and practice, and protect their creations most vigorously, while at the same time striving to share their creations as widely as possible – the raison d'etre of all artistic creativity in the first place.

Data, therefore, is a human right, it has always been a human right, to be used by all of humanity, young and old, rich or poor, literate or illiterate, in all the human cultures and languages available to humankind.

Some data has high commercial, political, military, or legal value, and must therefore be strongly protected against abuse.

With such broad meanings and uses, any attempt to control data as a whole will most likely fail, lead to dystopic "1984 style big brother" societies, or merely result in totally unexpected mostly undesirable outcomes.

Data that needs protection from abuse must be protected, but not at the expense of ordinary people trying to survive in this "Digital World". The process of data protection without undermining its human rights and ordinary usage is a complex task, there are technologies like Blockchain that can help, but all remain vulnerable to cybercrime attacks. The attention of governments and their regulatory agencies, and all technocrats, must be protecting that data that needs protection only, and encouraging the free flow of all non-sensitive data for the public good.

Policy makers must therefore first protect the rights of all citizens, irrespective of their demographic or social positions, and only thereafter focus strong attention on protecting the data that needs such protection. Failure to clearly distinguish between data for the public good, and data that needs protection, is probably the reason why South Africa's draft "National Data and Cloud Policy" received so many negative criticisms.

Coding and Robotics

A national debate concerning the introduction of coding and robotics education and learning in all South African schools has been ongoing for nearly a decade now. These most welcome debates have gathered momentum in recent years, as a direct result of the publicity around the 4IR, and the onset of the coronavirus. The coronavirus disrupted the education and learning in nearly all South African schools, which deprived too many of South Africa's children from effective learning. An example of the early years of this debate is the publication by ITWeb in 2015, which highlighted a few concerns by competent South Africans:

- Compulsory coding in school debate continues: Following an example from USA, a South African educator believes that coding should be a compulsory subject in South African schools, a graduating qualification for university entry.
- Problem: with some exceptions, IT taught in South African high schools is not good enough. "*There is a lack of teachers who can teach IT, and many of those who can move out of teaching into mainstream IT*".
- "*Across the broad base of South African high schools, we have still much work to do to lift the teaching of STEM subjects to the desired level. Yes, we need more young people learning these*

subjects but, no, we do not need to impose coding as a subject," says Adrian Schofield, director and VP of the Institute of Information Technology Professionals SA".

- Read the whole article here

The inclusion of the ITWeb article is merely to indicate that the debate has been active in South Africa for several years. There is an abundance of highly informative articles of the discussions in South Africa, too many to list in this very short introduction of the subject. More targeted research into how, when, and to whom to introduce this vital knowledge segment is necessary and urgent.

As part of this targeted research, examining the approaches taken by peer countries, both developed and developing, is strongly recommended. Countries like Finland, given its educational excellence, and Brazil with its progressive but sometimes chaotic educational systems, can provide invaluable insights:

Finland: Chosen for its global leadership in education, Finland began robotic tuition in schools in the 1990s. In the new education policy introduced in 2016, coding and robotics are fully included at all levels of schooling, but not explicitly. These subjects are weaved into the fabric of all other curricula, from grade 1 onwards, with some degree of specialization in the "handicrafts" curriculum. A major yet implicit focus on coding and programming is included in the math curricula, to the extent that by the end of grade 6, learners should be able to produce functional graphical programming. The country has several "schools" dedicated to coding and robotics, but these number far less than those in the public education system itself. Specialized coding and robotics are taught at tertiary institutions of higher learning. An interesting variant in Finland is the introduction of robots to "teach" young primary school children language and math, with of course the supervision of highly trained professional teachers. The excitement and enthusiasm of the learners was a pleasure to behold, and the results were impressive. The children encountered "coding" in a very practical sense, and prospered from it.

Brazil 2020: Research document: "*Educational Robotics Applications for the Development of Computational Thinking in a Brazilian Technical and Vocational High School*". Quote: "*Nowadays, solving problems is substantial for the social relationship human. Computational Thinking (CT) emerges as an interdisciplinary thought process encompassing mental abilities to help students solve and understand problems*". More research on Brazil's approach is necessary, given the exceptional success of Brazilian LAN Houses (cyber cafés) as reported in "Brazil 2020 Opportunity Tree: McKinsey & Company", 2019, updated 02 October 2021. ("Computational Thinking", translated from Portuguese, is akin to "Critical Thinking" in English).

Clearly, it is vital to include coding and robotics in all learning process in South Africa, but how? For whom and for what? A focus on the resulting "qualification" which promises "good jobs" to children who pass the lessons, and then fail to deliver such good jobs, is tantamount to a cure that is worse than the disease. Also, it is well-known that computer programming jobs, and robotics as a whole, fall within the categories of early automation – a well-designed robot can write computer codes far more efficiently and rapidly than mere humans. Such "qualifications" would therefore not scale well in South Africa, but they remain vital nevertheless.

The best approach is that adopted by Finland – weave the coding and robotics subject matters into all curricula throughout the school system, so that children will know enough to make the best career choices when the time to do so arrives. The low literacy levels of most South African children suggest this "weaving" of coding and robotics into all curricula may be a more effective way of providing this vital foundational knowledge.

There is one major fundamental flaw in the decision to include coding and robotics in South Africa's schools – the inequality monster raises its ugly head yet again. According to NEIMS 2019, only 36% of schools examined had computers available for teaching and learning, and just 20% had internet connections dedicated to teaching and learning. Those schools that have adequate computers and internet connections tend to cater for the wealthier children of the nation.

Any introduction of coding and robotics will thus favour the wealthier schools and the children that attend them, fuelling inequality further. The estimated 65% of South Africa's children who are poor will be left behind once more.

The obvious solution to this quagmire is to deal directly with the pro-poor ICT connectivity and use challenges first, and use the resulting solutions to speed up technological appropriation by the poor, starting with the youngest children wherever possible.

A short review of the preferred definitions of "coding" is useful to conclude this discussion.

Definitions of Coding:

1. Cambridge Dictionary: https://dictionary.cambridge.org/dictionary/english/coding:
   a. Verb that has an object (T): to represent a message in code so that it can only be understood by the person who is meant to receive it: The original signal is coded by the scrambler before transmission, and reconstituted into its original form by the receiver.
   b. Verb that has no object (I or T): to write computer programs (= instructions): *My third grade daughter loves learning to code with MIT's amazing (and free) software. - I have been learning to code programs.*
   c. (T) to mark something, for example with letters, numbers, a name, or a colour, so that you know what type of thing it is: - *To avoid bias in the laboratory, the samples were coded with numbers rather than names of individuals*. (ii) *Each story in selected bulletins was timed and coded into one of 31 categories for domestic news, while foreign news was separately coded by country.*
   d. More examples
      i Colossus to become the first to crack a message coded by the Lorenz cipher machine used by Nazi high command in the second world war.
      ii Anyone can learn to code, but the kind of responsibility you need to work from home you have either learned by age 10 or you never will.
      iii Explanations given by ten participants were coded independently by three individuals.
      iv Both questions were coded by interviewers on a 5-point scale (0 - 4) where 0 was none and 4 was four or more.

   Colossus – the first "digital" computer built in 1943 to "decode" Nazi "coded signals" during the war, 52 years before "digits" began to change the world, when "digital divides" were invented, which did little to bridge our information and knowledge divides.

   That first "digital" anti-war machine has grown to help defend the world against the multi-nuclear-warhead machines of today, which can be delivered at hypersonic speeds across whole continents, creating immense destruction wherever they land. We can, and should have, done better with the digits we invented, and the codes we used to manage those digits. The "Digital World" has allowed the weaponization of "coded digits" with potentially devastating outcomes for the whole world.

2. Definitions: https://www.definitions.net/definition/coding
   a. Noun: cryptography, coding, secret writing, steganography, act of writing in code or cipher;
   b. The process of encoding or decoding;
   c. A method of communicating important medical information discreetly and quickly between medical professionals and responders.
3. LEXICO (Oxford): https://www.lexico.com/definition/coding
   a. The process of assigning a code to something for classification or identification. *'the forms are checked and returned to the census officer for coding';*
   b. The process or activity of writing computer programs;

c. The process or fact of being the genetic code or determiner for an amino acid, protein, or characteristic: *'Experts predict that it could take the rest of the century to finalise the genetic coding that gives all human beings their distinct and individual characteristics.'*
d. Functioning as the genetic code or determiner for an amino acid, protein, or characteristic – The core of DNA – the genetic makeup of all living things is a "code".

4. Merriam Webster: https://www.merriam-webster.com/dictionary/code:

a. a systematic statement of a body of law, especially one given statutory force;
b. a system of principles or rules - moral code;
c. (i): a system of signals or symbols for communication; (ii): a system of symbols (such as letters or numbers) used to represent assigned and often secret meanings; (iii): coded language: a word or phrase chosen in place of another word or phrase in order to communicate an attitude or meaning without stating it explicitly;
d. Genetic Code: The DNA of everything
e. instructions for a computer (as within a piece of software), e.g., writing code for a new app.

5. Non-technological coding:

Coding is much more than developing codes and programmes for computers and robots - codes have been used by humankind throughout its evolutionary history for both good and nefarious reasons. The Christian and Hebrew Bibles, and the Koran as far as we know, have numerous references to both kinds of codes, e.g., the Bible or Torah codes; the famous Enigma Code referenced in the definitions above, and the popular DaVinci Code fictional art, believed by many to be true, are just a few further examples worthy of mention.

All these non-computer "codes" must also be included in the learning process for fully informed future generations.

CONCLUSIONS

South Africa is NOT a "digital" country. All its people and its coexisting lifeforms, its physical magnificence and deprivations, are all analogue. For equitable multidimensional human growth with dignity and peace, the country must urgently maximise the use of modern technologies, which includes all analogue and digital technologies, especially the ICT information and knowledge-delivering technologies.

This discussion document presents several misleading definitions and terms used in the vital ICT industry. All the technologies used by and within the ICT sector can/must be reduced to coding the natural analogue input data into digital representations for processing and dissemination, and decoding the digitally processed and disseminated data back to their original analogue forms, to be examined so that human knowledge can be enhanced, and decisions made from that enhanced knowledge.

In the opinion of the author of this document, Microsoft is wrong in interpreting the wisdom of the respected educationist Marc Prensky (The Role of Technology in teaching and the classroom, 2008) in its online lecture "What is a Digital World?", that:

"You think of technology as a tool. We think of it as a foundation -- it's at the basis of everything we do." (Prensky, 2008)

This statement is misleading, if not downright dangerous. For more than 3-million years, hominins have been inventing and creating technological tools to improve their living conditions, avoiding extinction along the way. They did a lot more than position technology as the basis of everything they did. The global migration of Homo erectus from its cradle in Africa nearly 3-million years ago, through all the intermediary evolutionary changes and admixtures of the genus *Homo,* to today's Homo sapiens, did much more than use technology as a basis for everything they did. The dangers of the

kind of thinking implied in the statement include the predictions, speculations and warnings by a growing number of respected thinkers, like the popular historian Yuval Noah Harari, who thinks that "*biotechnology and the rise of AI may split humankind into a small class of 'superhumans' and a huge underclass of 'useless' people. Once the masses lose their economic and political power, inequality levels could spiral alarmingly*" (reviews: BBC 28 April 2017, and The Guardian 24 May 2017).

Professor Harari's thinking follows the science fiction creations of several highly regarded authors, including award winning Canadian author Margaret Atwood's 2003 dystopian post-apocalyptic novel "Oryx and Crake", a work of fiction based on biotechnology, plagues, and extreme socioeconomic inequalities leading to the near collapse of humankind.

Many science fiction novels have had a habit of being too close to reality, George Orwell's "1984" novel comes easily to mind.

The "digital world" must be demystified in our classrooms so that all South Africa's children, the adults of tomorrow, will play a part in fostering the use of technology for humanity's survival and sustainability, in much the same way that their ancient ancestors used their technological innovations for survival and growth. Even if the children of today must live in a globally entrenched "cloud' of misinformation, they must be fully equipped to discern facts from market-driven hype, distortions, and outright criminality, so that they can make vital life decisions based on factual science, not the alternative facts of digits everywhere, including inside or on the vital water-bearing clouds.