Our Vision For South African Education
Driving Education Conversations & Solutions 2nd Edition
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For the past two years, the fourth industrial revolution (4IR) has been the phrase on everyone’s lips, from the World Economic Forum’s Professor Klaus Schwab, to an educator at an under resourced school in rural Free State. The 4IR has been met with caution, fear and distrust. On the same hand, it has been seen as a welcomed change which presents greater opportunities, better living conditions and easier access to basic needs. The divergent feelings and understandings of the 4IR contributed to this phenomenon being the theme for all the Education Conversations (the Conversations) we hosted in 2018. We needed to clarify and demystify the fourth industrial revolution before engaging how we could ensure our schools, our education system as a whole, embraces and is empowered by the 4IR, and in turn produces young individuals capable and skilled to make it in this fast changing world.

This book serves as a continuation of the first edition of Vision for South African Education (Visions), which showcased the various visions students had for South African education. This edition captures, once more, the Schooling Vision 2030 and additionally captures the fourth industrial revolution insights and solutions contributed by some of the Conversations’ previous guests, students and faculty of the University of Johannesburg.

Prof Kerry Kennedy articulates the 4IR question of what it means to be human in the 21st century and that this is a question that demands a firm response not just from economists and business leaders, but also from schools and education authorities. Students in schools right now will graduate in the midst of 4IR and they need to be prepared.

Tarryn Bennett and Koketso Nthimbane’s paper challenges how schools can be expected to transition to 4IR when the majority of schools in South Africa still grapple with access to ICT, a part of the 3rd industrial revolution.

4IR relevant education should be implemented from Grade R right through to TVET colleges and tertiary institutions, proposes Dr Tebogo Mashifana, as she substantiates how South Africa risks being relevant if 4IR changes are not affected.

Prof Elizabeth Henning deliberates on the 4 Cs that are crucial for life in the fourth industrial revolution and asks how does one educate for critical thinking and problem-solving, creativity and innovation, collaboration and teamwork, communication and information literacy?

Victorious Masoha promotes collaboration between government and the private and civil society sectors. This collaboration could find practical ways to infuse into our education system the 10 critical skills required to thrive in the fourth industrial revolution.

Azwidowi Libusha encourages creativity and innovation among mathematics teachers, sharing ways teachers can maximise the resources at hand and the already available technologies which can be incorporated to better impart knowledge to learners. A heartfelt thank you to all our Visions contributors. Everyone who attended the Education Conversations in 2018 contributed to the realisation of this publication and the solutions we derived – we appreciate the questions you raised and the bold statements you shared which led us to this stage. A special thank you to our panellists who availed themselves, some cancelled personal engagements while others travelled from out of town to ensure they contribute to the theme.

May our Vision for South African Education continue to drive us to be better citizens.
Schooling Vision 2030

The National Development Plan (NDP) “envisions a South Africa where everyone feels free yet bounded to others; where everyone embraces their full potential, a country where opportunity is determined not by birth, but by ability, education and hard work. Realising such a society will require transformation of the economy and focused efforts to build the country’s capabilities. To eliminate poverty and reduce inequality, the economy must grow faster and in ways that benefit all South Africans.”

We are Africans.

We are an African country.
We are part of a multinational region.
We are an essential part of our continent.
We feel loved, respected and cared for at home, in community and public institutions.
We learn together. We love reading.
Each community has a school,
teachers who love teaching and learning,
a local library filled with the wealth of books, a librarian.
All our citizens read, write, converse, and value idea and thought.
We are fascinated by scientific invention and its use in the enhancement of lives.
We live the joy of speaking many languages.

We need to ensure that all children can access and benefit from a high quality of education. This requires a range of early childhood development services and programmes that support the holistic development of young children. We envisage schools that provide all learners with an excellent education, especially in literacy, mathematics and science. The education system needs to improve constantly. The post-school sector needs to meet the wide range of education and training needs of people over 18. Together with the higher education system it will play a significant role in producing the skills and knowledge the country needs to drive its economic and social development. It will also be an inclusive system that provides opportunities for social mobility, while strengthening equity, social justice and democracy.

Kagiso Trust and 4IR

As an organisation initially established to liberate South Africans from apartheid, Kagiso Trust’s (the Trust’s/KT’s) 34 years have in no way made the organisation stagnant. Instead, the numerous changes which the organisation has had to make sur to the changed and changing political and economic climates has translated into an organisation aware of the importance of remaining relevant as Kagiso Trust strives to overcome poverty.

In order to ensure that Kagiso Trust’s development models remain relevant and competitive in the global landscape, KT had to understand the 4IR and optimise the opportunities this revolution brings and embrace the changes that inevitably come with it.

The Trust’s programmes and 4IR

Kagiso Trust’s programmes are categorized into 3 groupings: education development, socio-economic development (in agriculture and property) and institutional capacity building (in local government and civil society). Disruptive technologies will be critical in the Education, Property and Agriculture sectors to mitigate the challenges that arise from the digital divide. Challenges such as access to quality education, school infrastructure and curriculum can be mitigated by access to Coding skills, online education material and accredited courses.

The research afforded Kagiso Trust numerous insights into the 4IR. Below are some of the key learnings:

The Trust will be taking a lead in facilitating access to knowledge and skills required in the 4IR era for communities, in particular the disadvantaged, to take advantage of opportunities associated with disruptive technologies.

(Extracted from the National Planning Commission, National Development Plan, Chapter 9)
University of Johannesburg and 4IR: Industry 4.0 is being taken seriously

When she released the matrix recently, Basic Education Minister Angie Motshekga repeatedly referred to the fourth industrial revolution (4IR) and the roll-out of electronic devices to schools in the same breath. It is quite a breath to take, because a device in itself is no more than a tool.

Many schools in South Africa have poor infrastructure and struggle to do basic teaching. Also, our children do not read well enough and cannot do basic maths. The view of some is that our focus should be on getting the basics right.

Prof Sarah Gravett
Executive Dean of the Faculty of Education, University of Johannesburg

It stands to reason that teachers and parents alike want schools to prepare children and the youth for the future. But preparing them for Industry 4.0, as the fourth industrial revolution has become popularly known, is a tough brief.

The written ministerial statement provides some detail on the department’s take on 4IR in relation to school education.

It also refers to 21st-century skills, which generally means the competencies required to live and thrive (if not survive) in a rapidly changing world increasingly driven by technology, and in which artificial intelligence is becoming pervasive.

The statement notes that the Brookings Institute found that the South African school curriculum has embedded in it the competencies required for a changing world. These include critical thinking and problem-solving, creativity and innovation, collaboration and teamwork, communication and information literacy, as well as social justice and human rights. Apparently our school curriculum has the potential to foreground 21st-century skills.

The statement also expresses the need for the basic education sector to refocus the curriculum on a competence-based approach, integrating 21st-century skills into all subjects.

One cannot fault the intent expressed in the statement. Our children undoubtedly need to develop the competencies that will equip them (as far as it is possible to do so) for a world that is often characterised by the acronym VUCA — volatile, uncertain, complex and ambiguous.

So, how can we divert our already burdened resources towards 21st-century skills in our schools? Is this a luxury that we can ill afford?

Improving the so-called universal basic skills is thin on knowledge, as well as social justice and human rights. Apparently our school curriculum has the potential to foreground 21st-century skills.

Let’s take, for example, critical thinking and creative thinking. Thinking is dependent on one’s personal knowledge — what one knows. Critical thinking means, inter alia, that one is able to weigh evidence carefully and contemplate alternatives. This requires a knowledge base to draw on. Thinking creatively and innovatively is often the result of bringing together seemingly unrelated aspects of one’s knowledge. So, yes, some facts and detail can be googled, but even knowing what to google depends on what you already know.

I agree with the Centre for Curriculum Redesign (CCR) that the curriculum should be carefully examined to identify the core concepts and essential content that are significant to learn. Relevance is important and, to use the words of the Harvard academic David Perkins, there should be an emphasis on what is “lifeworthy” in the 21st century.

To get “lifeworthy” knowledge to children and youth does not require an overhaul of the existing curriculum, but a pruning of the curriculum content to create space for including 21st-century skills deliberately and purposefully.

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 trim the curriculum in this way would be challenging, particularly because many equate quality with quantity.

Another stumbling block is expert bias — experts who would zealously argue for content in their field of expertise to be retained. Nevertheless, deep learning is not possible in a crowded curriculum.

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Another stumbling block is expert bias — experts who would zealously argue for content in their field of expertise to be retained. Nevertheless, deep learning is not possible in a crowded curriculum.

Also, many frameworks have been drafted worldwide for 21st-century education. Some of these are the CCR Framework, the Organisation for Economic Co-operation and Development Learning Compass 2030 and Unesco’s Framework of Future Competencies set for a new 21st-century world.

Integrating 21st-century skills in the curriculum requires careful decisions about which competencies to focus on during schooling.

Third, teacher education and development are crucial. Teachers will have to be prepared for implementing 21st-century education.

These are a few issues that initial teacher education must address:

How do teacher education curriculums prepare student teachers for teaching in a VUCA world?

Are teacher education curriculums overloaded, sometimes with content reflecting academics’ personal interests and topics that are not truly related to our current (and future) reality?

Are teacher education programmes assisting student teachers to develop a deep understanding of essential concepts and content? Are we paying sufficient attention to digital and information literacy?

A pilot project on 21st-century education, the Sandbox Project, is under way in a few primary schools. It is being spearheaded by the National Education Collaboration Trust (NECT), whose innovation hub, EdHub, joined similar units around the world in reviewing how schools should contribute to preparing children for the 21st century.

NECT has partnered with Harvard University’s affiliated CCR, the Russia-based Global Education Futures and the University of Johannesburg’s (UJ’s) faculty of education to drive the implementation of this initiative.

A framework for 21st-century learning has been developed and 10 public primary schools (sandbox schools) have been selected in the Waterberg district of Limpopo, where a pilot study will be under way this year. The Fundação UJabule School on the UJ’s Soweto Campus will also participate. The project is meant to inform us about how 21st-century competencies could be infused into schools.

While implementing the pilot, UJ academics and postgraduate students will also research the implications for teacher education. Working in a research laboratory school, such as the one on the UJ Soweto campus, gives us the opportunity to observe and to record how teachers deal with a sandbox curriculum.

The Waterberg schools may show us what the possibilities and challenges are in everyday practice, which is why we need — how to proceed in everyday practice with a feasible curriculum for the future that our children face.
About the Education Conversations

Established in 2012, the Education Conversations (the Conversations) is an initiative by Kagiso Trust and the University of Johannesburg Faculty of Education. The Conversations are aimed at encouraging the country to talk and create space for debates and discussions through which diverse voices can be heard focusing on what works and how to collectively advance the agenda for an improved and performing public education system.

In addition, the principles of the Education Conversations partnership include:

- Encouraging stakeholders in education to move away from the pathology of focusing on what is not right with the country’s education system and rather focus on creating solutions to challenges faced by the system; Encouraging stakeholders in education to play a role in transforming South Africa’s education;
- Holding all stakeholders in education accountable and responsible for the performance of South Africa’s public education system; and anchoring the participation of the Department of Basic Education, as critical in these conversations;
- Previous panellists have included, but are not limited to: Dr Stephen Taylor (Researcher: DBE), Mr Mugwena Maluleke (General Secretary: SADTU), Mr Panyaza Lesufi (MEC: Gauteng Department of Education)
  
Mr Mantanzima Mweli (Director General: DBE)

Mr Enver Surty (Deputy Minister: DBE) and recently,

Mr Godwin Khosa (CEO: NECT).

During the month of October 2018, the Faculty of Education launched the Robot Teacher competition.

We asked our students as future teachers to imagine if they could ever be replaced by a robot or if a robot could help you do your work as a teacher better. Students had to think about what a teacher does in their everyday classroom work and consider the following:

- What if many of the tasks of a teacher could be done by a robot? What are these tasks?
- What if the robot could do some of these tasks better than a human teacher? Which tasks could a robot do better?
- What will the role of a teacher then be?
- Will teachers still be needed?

Here are some of the reflections from the students:

**Dimakatso Nxumalo**

Having robots in the classroom can perpetuate both development of social skills and inclusivity. Firstly, Robots encourage learner’s technical skills and interests. Robots can play the role of peer or teacher, encouraging or instructing learners, for example in foreign-language study. One preliminary study suggested that humanoid robots boosted motivation, community and self-expression in low-income learners.

Learners who encounter individual challenges in mainstream schools like stuttering, poor concentration, language learning (immigrants) or are on the autism spectrum, can count on only little extra time of special education per week. This is not a sufficient support for the inclusion of learners with difficulties or autism. Robots can become a supporting tool in solving this issue as they can provide additional special attention and serve as assistants to the teachers. For Autism(ASD), Robots can help these learners in the classroom by Modelling eye contact and other social behaviours like storytelling and interactive games designed to promote social skills such as emotional understanding, better communication and confidence.

**Sandile Maseko**

Robot teachers can strengthen scientific and technological culture in schools. They can also be tools to facilitate the transfer of knowledge through trans-disciplinary activity-based-projects. Robots teachers are ideal artifacts for making abstract knowledge concrete. For instance, for teaching real-world application of Maths, science, programming and engineering. Lastly, robots teachers can be good tools for applying scientific thinking through enquiry-based activities.

**Nasreen Khan**

There are a great many tasks that teachers are faced with and robots could effectively do a great many of them. For example, robots could do various administrative tasks that teachers do on a daily basis (taking a register for example) which would then free up their time to teach more and engage more with the learners. The robots could also do other administrative tasks such as filling in forms by using a voice-to-text function thus, teachers will not need to sit and write or type but can merely speak to the robot and the forms can be filled out. Furthermore, they can also facilitate various assessments and collect data based on it thus leaving only the evaluation for the teacher. Additionally robots could act as an aid for teachers. Teachers can focus on the learners who need the attention while the robot can facilitate various (educational and interactive) activities for learners who are at fault with the content and at that point do not need the extra attention.

**Armand van Niekerk**

Robots are much more efficient than teachers ever will be- While teachers are forced to deliver the majority of learning in a whole-class setting, artificial intelligence can deliver tailored learning, carefully evaluating every response to calibrate when to stick with the current topic and when to move onto the next. The brightest learners can be given additional work, while those that need additional help would receive it, all within the same class. Artificial intelligence offers almost unlimited possibilities in terms of identifying student’s strengths and interests and building on them. Even teachers admit that robots are good-Perhaps surprisingly, teachers seem to like robots, once they’ve worked with them at least. While teachers generally expected robots to be disruptive, in reality they reported that they were not and teachers can develop numerous positive ideas about the robot’s potential as a new educational tool for their classrooms.

**TALK & CREATE SPACE FOR DEBATES**
Exploring the Fourth Industrial Revolution

The main theme for the 2018 Education Conversations was the Fourth Industrial Revolution (4IR). The theme proved relevant, topical and allowed various stakeholders to lend their voice to how South African education can and should embrace the 4IR.

Three topics were explored during the course of the year:

1. Understanding the 4th Industrial Revolution and its impact on the education system
2. Connections and disconnections within the education value chain which influence success during the time of the Fourth Industrial Revolution
3. Making 4IR education a reality in all our schools

Understanding the 4th Industrial Revolution and its impact on the education system

Date: 17 April 2018
Venue: University of Johannesburg, Auckland Park Kingsway Campus
Speakers: Mr Godwin Khosa, NECT Chief Executive Officer and Dr Jacqueline Batchelor, UJ Faculty of Education

Summary:
The first instalment of the Education Conversations in 2018 examined our understanding of the ‘changing world’, and unearthed implications and impact of the 4th Industrial Revolution on our education system. How can we ensure that our country has the necessary skills to adapt and keep up in this changing world? How do we teach a googled learner?

The solutions proposed indicated a move to learner-centric approaches in engaging and stimulating teaching, real-time assessments, access to data and technologies and freedom of creativity to explore innovative ways to impart knowledge to learners.

Connections and disconnections within the education value chain which influence success during the time of the Fourth Industrial Revolution

Date: 24 July 2018
Venue: Funda UJabule School, Soweto

Summary:
The vast and growing potential of the Fourth Industrial Revolution is yet to be fully grasped. The ICT sector, industry and governments have a responsibility to unlock its potential for citizen service delivery, customer experience and innovative solutions, for a better life for all.

Proposed solutions:
Key outcomes included an appreciation of the progress government is making in piloting specialised science and technology schools; the importance of having a global view and implementing best practice to better prepare and equip the education value chain; strengthening collaborations with the private sector in ICT and telecommunications; as well as adopting the agency to develop solutions he challenges facing the education system.

Making 4IR education a reality in all our schools

Date: 18 September 2018
Venue: University of Johannesburg, Auckland Park Kingsway Campus
Speakers: Sonqoba Maseko, Former Sifiso Learning Group COO, Dr Andile Mlotywa, Business and Social Research Institute Managing Director, and Professor Caroline Long, UJ Faculty of Education

Summary:
As the latest buzz word across sectors, the 4IR has signalled a changing world. As a result, in order to survive in this new world, we need to change with it. One of the key issues that has come up has been that of acquiring and imparting ‘skills for a changing world’, as Dr MJ Maboya from the Department of Basic Education puts it.

This last instalment of the Education Conversations in 2018 will explore practical ways 4IR can be adapted in our classrooms, with the intention to share these solutions with the Department of Basic Education.

Proposed solutions:
A concerted effort at ensuring effective digital learning, mindful of easy access; blending of online and offline learning; teacher training; quality assurance; big data management and sharing and collaboration of content and best practice. Other considerations include learning through play, funding of the transition from traditional to 4IR classrooms, security of technologies, and the alignment of content being taught (skills acquired) to the realities of jobs which will be available when the learners enter the market. Finally, the conversations stressed the important role of TVET colleges and tertiary institutions also being included as the education system readies itself for the 4IR.
Another Industrial Revolution: What schools need to know

Prof Kerry Kennedy
University of Johannesburg
kerryk@uj.ac.za

The Fourth Industrial Revolution questions what it means to be human in the 21st century. It is a question that demands a firm response not just from economists and business leaders, but also from schools and education authorities. Students in schools right now will graduate in the midst of 4IR and they need to be prepared.

The Fourth Industrial Revolution (4IR) is not something that is being predicted – it is happening right now, here in South Africa and across the globe. Even if there are aspects not happening locally, globalisation will ensure that significant changes over which we have no control will influence such diverse activities as manufacturing processes, service industries, energy development, medical procedures and weapons production. This will result in disruptions to areas such as the economy and labour markets, producing positive outcomes for some, and very negative outcomes for others.

There will be winners and losers from 4IR. Now is the time both to understand exactly what 4IR is and to prepare to master its influences rather than be mastered by them.

Digital devices are now ubiquitous in modern societies, even though there is a significant digital divide both within and across societies. For those who have access to handphones, computers and portable/wearable devices of different kinds, daily living is constructed around these. Handphones, for example, now double as cameras, platforms for multiple applications including banking services, games, e-mail, methods of payment, social media etc.

This so-called “digital revolution” has changed people’s lives in many ways but the devices themselves support and supplement basic human functions. This digital revolution is sometimes referred to as the Third Industrial Revolution (3IR) and it is basically over. Even though phone companies continue to upgrade and refine their products – better cameras, better wearable devices and larger processing capacity catering for what often seems like an infinite number of applications – it is product enhancement rather than innovation.

The 4IR, on the other hand, is much more than the production of powerful devices. Like the digital revolution, 4IR relies on technologies, yet they are technologies that have the capacity to perform what have until now been considered human tasks. It might be robots capable of giving directions at a railway station, or assisting with medical procedures or interacting with autistic children in classrooms. It could be 3D printers capable of producing body parts, weapons or even houses. It might be driverless cars. It might be computers that do not need to be continuously programmed because they can re-programme themselves based on the data they collect. And, based on this data, they can make predictions about anything from identifying the optimal marketing strategy to who will win an election.

This kind of artificial intelligence (AI) is what drives social media such as Facebook, which relies on the data generated by its membership base not only to attract advertisers but also to on-sell it to whoever is in the business of making use of such “big data”.

What all of these examples have in common is that they demonstrate not just the development of new technologies, but the ways these technologies integrate human and technological capacities, often to perform tasks previously thought to be human.

The 4IR questions what it means to be human in the 21st century. It is a question that demands a firm response not just from economists and business leaders, but also from schools and education authorities. Students in schools right now will graduate in the midst of 4IR and they need to be prepared.

Schools can also teach with 4IR technologies. Social robots have already been shown to be useful adjuncts in the teaching of students with certain special needs. A recent study identified over 300 academic papers that have explored the issue of robots in the classroom and educational contexts. AI can create databases of assessment items that can provide feedback to students on their learning progress. What is more, based on student responses, computers can generate new items that respond to a student’s level of learning. And 3D printers are already in some school systems, requiring design skills of a very high order to create new and innovative products. It is not too much to say that 3D printing has turned design education on its head.

Virtual Reality has been shown to work throughout different levels of schooling, heightening subject engagement, enlivening teaching and facilitating learning. It can provide for independent and personalised learning even though the curriculum itself might be common since students can dictate their own pace to move towards desired outcomes. Together, these 4IR technologies revolutionise what is meant by “school education” to make it not only engaging but relevant and linked to the real world.

Schools also have an important role in preparing students for 4IR. The key skills and values are creativity, critical thinking and problem solving – these have been widely endorsed and there should be nothing in the school curriculum that does not facilitate these skills and values. For example, many people advocate computer coding as a component of the 4IR curriculum, but this misses the point.

If computer coding leads to innovative, creative and critical thinking then it has a role to play, if it is about the routine application of rules then it does not. A robot can apply rules – computer coding must contain elements that use human skills as well as technical skills. This raises a key issue. Along with the skills and values referred to above, there must be one other key component: the curriculum must teach students what it means to be human. Many commentators have made the point that if a robot can do it, it’s not worth teaching. What makes humans human and how can they be more so; this is an essential complement to being a creative, critical problem solver.

But how are we to get there?

The message here is for politicians and policymakers. Schools must be equipped for teaching with and about 4IR. Nineteenth-century schools do not prepare students for the 21st century. Teachers must be prepared not with outdated teaching methods and approaches and a standardised curriculum that is relevant to no one.

Resources are needed to transform education so it can meet the needs of 4IR. There is little to be gained from crying poor when it comes to resourcing this kind of education. Without such resources, the challenges will not be met and this will be to the detriment of the whole of society. In particular, however, it will affect the most vulnerable in society and those for whom schools are the only social safety net to making them 4IR-ready.
Preparing Pre-Service History Teachers for the 4th Industrial Revolution

The fourth industrial revolution has been a trending topic in the education realm. Although it is good to keep up with the technological advancements, South Africa may not be ready for this 4IR, but it is unavoidable. Before we explain any further, we find it imperative to understand the progression of the different industrial revolutions. Below is a diagram showing the progress over time.

![Diagram showing the progression of industrial revolutions](Image)

The fourth industrial revolution is described as a series of cyber-physical systems that is created from the third industrial revolutions advanced automated technological production (Ismael, 2017). Defined in simpler terms, the fourth industrial revolution is about captivating all the advanced technology and using it innovatively and creatively.

It is difficult for the education system to fully participate in the 4IR in South Africa, if the “digital revolution” or 4IR was not fully integrated (Roberts, 2015). Many schools in South Africa have not embraced technology into their schooling system, due to poverty constraints or lack of funding (Bernstein, Brits, Mela, Mogadime, Naidoo, Qabazi, Schoeman and Warpenaar, 2017). Nonetheless, as a country, we need to keep up with the advancements of the global community, especially in the education system. If schooling systems need to keep up with the transitions of technology and adapt to the 4IR, so does the university system in training pre-service teachers.

History teachers are expected to teach learners how to interpret history through reading, writing and thinking like a historian (Wineburg, 2001). However, the question that usually arises from pre-service teachers is: ‘How do we bring technology into a history lesson?’ History is defined as the past on society that influences the present and the future (Hirst, 2016).

Therefore, it is logical for pre-service teachers to ask this question because it bears significant implications for the future. In the classroom, learners should be exposed to different types of sources and interpret it like a historian while analysing it (Bickford, 2013). This allows for learners to think in the past but also applying it to the knowledge they have about their present history, as well as connecting literacy skills such as reading and writing to create meaning and understanding.

Nevertheless, we do not agree with Bickford’s (2013) manner of teaching history today. One of the first theories pre-service teachers learn about is Pedagogical Content Knowledge (Shulman, 1986) identifies teachers’ understandings, orientations and concepts of the subjects they teach, as content knowledge. “To think properly about content knowledge requires going beyond knowledge of the facts or concepts of a domain” (Shulman, 1986, p. 9). Thus, pedagogical content knowledge highlights the importance of teaching topics through diverse learner interests and abilities (Shulman, 1986). These diverse interests and abilities should include creativity and innovation.

We are not merely talking about showing the learners pictures and videos. What is meant here is that teachers need to go beyond the norm of the textbook, teaching strategies by first evolving through the four phases of the 3IR namely data processing, personal computing, network computing and cloud computing. The only way for pre-service teachers to adapt to the 4IR, is for the lecturers to model it into the curriculum (Penprase, 2018). Lecturing is very different from teaching; however, pre-service teachers need to gain an understanding of how to use 4IR history teaching strategies in their 4-year degree.

Learners are exposed to so many technologically savvy applications, that they could know more about technology than their teachers (Bester & Brand, 2013). So not use the learners’ strengths, and creatively adopt it to a project or lesson? At one of the universities in Johannesburg, 3rd year pre-service history teachers are learning how to re-create a moment in history. Thus, they are taking the teaching strategy of role-play, and creating a video which has to be edited and narrated.

**Table 1: Status of access to ICT infrastructure in South Africa**

<table>
<thead>
<tr>
<th>Year</th>
<th>Access to Computers (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009</td>
<td>15%</td>
</tr>
<tr>
<td>2016</td>
<td>35%</td>
</tr>
</tbody>
</table>

We can see from Table 1 that in 2009 only 15% of schools in the entire country had access to computers. However, by 2016, 35% of schools had access. This means that in the 7 years between 2009 and 2016 access to computers for teaching and learning had only improved by 75%, which reflects a 1.08% annual increase. This would substantiate the relatively high learner to computer ratio as presented in the table above.

Furthermore, it is evident that the poorest schools are still neglected because access is limited to quintile 3, 4 and 5 schools. Although 80% of schools in Gauteng have a computer laboratory, access for learners is still very limited. These statistics lead to a very pertinent question, how can the South African education system participate meaningfully in the 4IR while still grappling with minor access issues?

In the effort of generating systematic transformation, we are aligned with Aomy’s (2013) 3M theory developed for schools in rural and poverty stricken areas. This theory considers improvement of a system at the macro (national level), meso (provincial and district) and micro (school) levels. According to Aomy, (2015)’s best practice assumes:...
If we are reluctant to change, being irrelevant is inevitable

It is not a question of if it will happen, but when will it happen? When will we cease to be relevant? If we choose not to adapt to the world that is changing. If we say we are in a developing country and want to see ourselves being relevant in the global space, transformation in our education system is prominent. 4th Industrial Revolution in our education system cannot be ignored any longer. The use of technology in our classrooms cannot be postponed anymore. As much as many believe that the 4th Industrial Revolution is bringing a change that will result in numerous job losses, we should never ignore the danger of being reluctant to transformation. If we want to compete in a global space, if we want to produce graduates that are in touch with technology in the world that is technology driven and can compete globally, if we want to begin to use education and technology to solve societal challenges in our country, we must adapt.

We have heard that companies are losing their jobs because of closing their branches and people are losing their jobs because of digitalization. This should be an eye opener for the decision makers in the education system that if the skills that are required for this era are not introduced and taught in the classroom, the technology driven industry and work force will reject the learners and students produced from our education system.

It has recently been announced by the Minister of Basic Education, that South Africa is developing a coding and robotics curricula to be included from grades R-9 (Business Tech, 2019) and this will prepare our learners for the 4th Industrial Revolution. This is a great move by basic education and the critical skills, such as critical thinking, creativity, complex problem solving, soft skills should be next to be incorporated in the curriculum. There are things that robots cannot do, it is therefore crucial that we identify those things and we strengthen those areas in the curriculum and the learners we teach. That way, they will never have to compete with robots. The sooner South Africa embraces and fully incorporates the 4th Industrial Revolution in the education system and the personnel who are entrusted to disseminate knowledge to educate adapt to the change that has come, the sooner we will realise and begin to teach our learners the critical skills that are crucial for this era, so that they continue to remain relevant.

So what does the 4th Industrial Revolution mean for the education system in South Africa? I might not have all the relevant answers but with the experience I have in incorporating technology in teaching and learning and in observing some of my colleagues in Higher Education Institutions use technology for teaching and learning, there is no doubt that teaching and learning with technology makes the learning exciting, effective and efficient. There is a revolution in how teachers/lecturers are expected to teach the students and learners in the classroom. The assessments have become exciting and with the sole purpose of assessing to ensure that learning has taken place. Through the online formative and corrective assessments, students are able to test their knowledge of the subjects taught over and over again, until an understanding is attained.

There is no doubt that the 4th Industrial Revolution has brought efficiency in conducting tasks. The use of machine, technology is continuing to make things easier, whether in the classroom or in the industry. This same change calls for a change in our curriculum, so that we teach what is relevant to the learners, the work force and the industry. The time to accept, embrace the revolution we are in, is now. The sooner we do it, the sooner we will realise all the skills that we need so that we remain relevant in the world that is continuously changing.

While we are already in the era of the 4th Industrial Revolution, it is important that we close the gap that has been there for so long, the gap between the higher learning education and the basic education. Education about 4th Industrial Revolution has to begin in Grade R and all the way through primary, secondary, TVET colleges and universities. Technology has to be implemented in all our classrooms. The critical skills that are crucial for this era must be taught and be instilled in the teachers and lecturers that are teaching the learners and students.

In so many other countries industries are completely digitalized, robots are doing all the jobs. Do our learners in primary school, let alone high school, even know what a robot is? Do they even know how they work, why should robots even exist? That knowledge is key in our education system and all learners must have this knowledge. The majority of the population in developed countries has free or affordable access to internet connection, this means access to knowledge. We cannot disconnect the two, if we desire to adapt and be relevant in the 4th Industrial Revolution, the challenges of expensive data, which is a barrier to access to information and knowledge, must be dealt with accordingly in the country. One of the major differences between developed and developing countries is access to information and knowledge through internet/data.

South Africa is moving in the right direction by implementing new modules that are related to the 4th Industrial Revolution in the basic education system, but is the curriculum in the higher education institutions relevant for the era we are in? Are the educators adapting to the change that has come? Are we preparing our graduates for the industry that has come to be, which is technology driven? If we do not change and adapt, if the curriculum taught in the classroom is not changed, at some stage we will cease to be relevant.

Reference
Three Rs plus playful classes builds creativity, critical thinking

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There has not been such a burst of interest in plans and programmes in South Africa’s education system for a long time. From preschool to university, practitioners, researchers and opinionistas are talking about the fourth industrial revolution (4IR). It makes sense that the place to start preparing for a life with artificial intelligence is the school.

What must happen before we can even think of primary schools doing that? The minister of basic education, Angie Motshekga, appeared to strike the right chord when she said to journalists at a recent meeting: “We must get the basics right first.”

And the basics are the three Rs. Imagine what adventures children can have with coding if they can read well and grasp maths in some depth. And just think of how helpful it could be for children if they had some sense of the nature of science when they start designing and making things on devices.

But what about the four Cs — critical thinking, creativity, collaboration and communication — that are crucial for life in the 4IR and which my colleague Sarah Gravett referred to in an article in the Mail & Guardian (Industry 4.0 is being taken seriously, January 18)? How does one educate for critical thinking and problem-solving, creativity and innovation, collaboration and teamwork, communication and information literacy?

In our research centre at the University of Johannesburg (UJ) Soweto campus, we have learned a few valuable lessons about the four Cs: children are creative and innovative, they can solve problems, they can think (very) critically and they are keen communicators.

By the time they enter school, they are already playfully engaging with the four Cs at their level of development. They have already created playthings and have made up their own games, collaborating with their peers and siblings. They have solved the problems they face in their play world and they have learned how to communicate — often in different languages.

So, what goes wrong when they go to school? Why does the future for the grade 1 class of 2019 look bleak?

The grade 1 class of 2019 are perfectly good citizens of our times, ready to design robots and to engage with machine learning. They have, by virtue of the evolution of our species, developed brain power that can, ultimately, live with algorithms; these little people have human intelligence.

What they don’t have is knowledge and skills that are very recent in human history — reading and mathematics. They have to learn to read and to make their world mathematical. Someone has to teach them. It does not happen naturally.

It is only recently that our brains have had to “recircuit” their visual powers to learn to read. And it is only recently that we started structuring the world mathematically.

Cognitive neuroscientist Stanislas Dehaene, of the Collège de France in Paris, has written two compelling books about this learning. He writes convincingly about the challenges of growing from being the playful toddler to the serious child student of the alphabet and of number.

Contemporary young humans learn because they are instructed in some structured way. Such learning does not happen spontaneously, as play does. It is organised and it is assessed regularly to find out how they are progressing.

There is not much time in school for spontaneous, imaginative play. This means there is less time to create, to design, to solve childhood problems, such as where to hide when playing hide-and-seek and how to manage peers in a world of joint fantasy.

Children’s spontaneous play has all the characteristics of the four Cs.

To address the importance of play, the Lego Foundation is sponsoring the Lego Professor of Play at Cambridge University, where studies will include how “children are equipped with 21st-century skills like problem-solving, team work and self-control”. The recently appointed chair, child and adolescent psychiatrist Paul Ramchandani said in an interview with The Independent in 2017: “Everyone has an opinion about what role play should have in early education and there is some wonderful research, but there are also big gaps in our knowledge.”

For many in education, play is still divorced from serious, deep learning. It is slotted into that time during the school day when teachers use it as a medium to teach, knowing that it has educational value, but often for relief and “fun” during the long school day. Children take on a role and the teacher structures some of the plot. I think, though, that much more can be done to harvest the richness of the four Cs with which children come to school.

One of these is to let children produce artefacts — to be makers in playful makerspace classrooms. My student Rellwé N is a teacher, and she studied teaching aids for mathematics in foundation phase classrooms. She concluded that children, themselves, should design artefacts for learning to count, to calculate and to make their own “playthings” for learning about time, space and number.

Another student, Francois N, found that when children make their own models of the solar system, using clay, that teachers have a more direct glimpse into children’s conceptual understanding. This type of “making” is playful.

Play, in its broad sense, does not mean only acting and speaking, though. Play is also not limited to games — which suggests that it is not only a medium for learning, but also a source of educational value, but often for relief and “fun” during the long school day. Children take on a role and the teacher structures some of the plot. I think, though, that much more can be done to harvest the richness of the four Cs with which children come to school.

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Play, in its broad sense, does not mean only acting and speaking, though. Play is also not limited to games — especially if its strongest characteristic, namely imagining, is replaced by “rules of the game”. The design-thinking element is best observed in preschool groups who have only a few objects with which to invent a playful scenario. In fact, children with too many manufactured toys often do not quite know what to do with these, unless there are rules and they are playing a structured game.

The Lego Foundation conducts research about learning though play, which suggests that it is not only a medium for learning, but also a source for learning and development.

“Neuroscience helps explain how playful experiences can support learning. We find that each characteristic — joy, meaning, active engagement, iteration and social interaction — is associated with neural networks involved in brain processes. These processes include reward, memory, cognitive flexibility and stress regulation,” the research reads, in part.

There is really no manual for creativity, collaboration, communication and critical thinking. The best schools can do is to make sure that the three Rs and a knowledge- and competency-rich curriculum has space for playful, innovative engagement.

For schools to teach critical thinking, for example, requires much wisdom from those who advocate it. I agree with @rpondiscio (Robert Pondiscio, vice-president for external affairs at the Thomas B Fordham Institute in the United States and adviser to Democracy Prep Public Schools) that children cannot become critical thinkers by acquiring this crucial competence in a knowledge vacuum. For starters, to engage with the algorithms critically, you need to know quite a bit about them.
South African Education System and the Fourth Industrial Revolution

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“The education system should be very intentional in ensuring that [4IR] skills are incorporated in the overall education system of this country.”

A burning question which our government needs to answer is: are South Africa learners prepared for what the future holds as it relates to the Fourth Industrial Revolution? Is our government doing enough to ensure that our learners have acquired the necessary tools and skills to prepare them for the Fourth Industrial Revolution? Is our education system in a position to provide such tools and skills to our learners? These questions are very important questions which need to be answered by government institutions within the education system of our country.

South Africans are interested in finding out what the Fourth Industrial Revolution means for the country and in particular what it means for our education system. This topic is of great interest to us as a non-profit company which is focused on improving the education system of our county. Our organisation, Victorious Girls Foundation is a registered non-profit company which was established in 2017. Our main aim is to empower high schools girls to maximise their potential in life by providing them with practical tools and solutions on how to positively navigate through life. We are very passionate about what we do and we believe that our foundation is one of the organisations which government can partner with in ensuring that our schools are equipped to embrace the Fourth Industrial Revolution.

Our education system needs to be in a position where it is prepared to embrace the Fourth Industrial Revolution. However, where a significant amount of schools are in serious need of basic sanitary facilities, it is a challenge to see how these schools will have the right tools to embrace the Fourth Industrial Revolution. The right tools and skills have to be put in place in order for the education system to take full advantage of the Fourth Industrial Revolution. There needs to be a national roll-out of technology and training of teachers to equip students with skills needed to thrive in the Fourth Industrial Revolution.

According to the World Economic Forum (www.weforum.org), the following 10 skills are needed to thrive in the Fourth Industrial Revolution:

1. Complex Problem Solving
2. Critical Thinking
3. Creativity
4. People Management
5. Coordinating with others
6. Emotional Intelligence
7. Judgement & Decision Making
8. Service Orientation
9. Negotiation
10. Cognitive Flexibility

The education system should be very intentional in ensuring that the above mentioned skills are incorporated in the overall education system of this country. This is a huge task for government, therefore the private sector and non-profit organisations focused on the education system should also play their role in ensuring a conducive environment for the Fourth Industrial Revolution. The time has come for government to create platforms for constructive dialogues to take place between government, the private sector and non-profit organisations. These dialogues should result in partnerships with formal memorandum of understanding in place so as to ensure clear roles and responsibilities as it relates to all parties.

Education is a life long journey which does not end at matric or at the end of university, therefore as South African citizens, we all have a role to play in ensuring an effective education system as it relates to the Fourth Industrial Revolution. Technology and innovation is part of life and our role as a country is to find ways to make them work for us, instead of against us. Let us all work together in ensuring that our learners are prepared for the future by ensuring that they have the right set of skills and tools to embrace the changes that the Fourth Industrial Revolution is bringing in our education system.
Teaching mathematics in the Fourth Industrial Revolution

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The world has changed and it is continuing to change radically by the day. Our world is now controlled by social media. Social networks, mobile platforms and apps, advanced analytics and big data have taken over what seems to be our social lives. All this is due to the shift in technological capacity. It is now a prerequisite for the education system and those teaching to change with the global society. This implies that there is a need for teachers to prepare their learners for an ever-changing workforce and society at large. We can either stand aside and criticize technology for all the bad things it has introduced our kids to or use it to our advantage. The teacher always played an important role in establishing effective teaching of mathematics. There is no way that I am suggesting or implying that there is a need for the replacement of a teacher in a mathematics classroom.

However, the time has come for mathematics educators to start relying on something more than just a pen and paper or chalk and board. Studies have shown that when information is on a visual format, learners can process and retain information faster and with more reliability. Visual breaks down information into manageable pieces that are easier to absorb and also increase learners’ interest in the subject matter. Although research has suggested that for the majority of teachers, the simple access to technology is insufficient for the successful integration of technology into their teaching practice (Cuban, Kilpatrick and peck, 2001). It is time that teachers are taught the importance of technology. The majority of the learners in urban areas are exposed to smart phones and other digital platforms and hence there is a need to improve. A good teacher knows when to improvise when teaching, by means of using a variety of approaches to increase learners mathematical skills and their understanding of mathematical concepts. Bringing in the use of technology as a thinking tool to assist learners to reason can also be considered as one of the approaches. In mathematics education, there is different software like GeoGebra, Geometer Sketchpad, Autograph and others which are designed to combine geometry, algebra and calculus in a single, dynamic user interface. It will be of great importance for educators to be introduced to adequate and ongoing training together with friendly support to increase teacher’s willingness to integrate technology into their teaching. Our education system should also develop successful technology-assisted teaching practices in order to accommodate the learner in the era of the fourth industrial revolution.