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Fourth Industrial Revolution (4IR) Webinar Report

By

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*The Impact of 4IR Technologies
on the Education Sector*

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LIST OF ACRONYMS AND ABBREVIATIONS

4IR:	Fourth Industrial Revolution
AI:	Artificial Intelligence
COVID-19:	Coronavirus Disease 2019
CSIR:	Council for Scientific and Industrial Research
DBE:	Department of Basic Education
DED:	Department of Economic Development
DHE:	Department of Higher Education
DOL:	Department of Labour
DST:	Department of Science and Technology
DSTI:	Department of Science, Technology and Innovation
DTI:	Department of Trade and Industry
ICT:	Information and Communications Technology
ISTEAM:	Innovation, Science, Technology, Engineering, Arts and Mathematics
MPs:	Members of Parliament
PRU:	Parliamentary Research Unit
PSET:	Post-School Education Training
RPL:	Recognition of Prior Learning
STEM:	Science, Technology, Engineering and Mathematics
TIA:	Technology Innovation Agency
WEF:	World Economic Forum

1. INTRODUCTION

The Fourth Industrial Revolution (4IR) is upon South Africa and Africa as a continent, and young people have a huge role to play in Africa's development during the new digital era. With such a high population of young minds, the question should not be about South Africa's readiness for the 4IR, but rather the role young people will play in promoting it.

The 4IR could be described as the advent of “cyber-physical systems”, involving entirely new capabilities for people and machines. It represents entirely new ways in which technology becomes embedded within societies and even our human bodies. Examples include, amongst others, genome editing, new forms of machine intelligence, breakthrough materials, and approaches to governance that rely on cryptographic methods such as blockchain. According to the World Economic Forum (WEF), the top three (3) skills required to thrive in 4IR include: complex problem solving, critical thinking, and creativity. These skills differ from the top skills listed by the WEF in 2015. As such, for the youth to be able to contribute to the 4IR, they need to upskill.

2. BACKGROUND¹

In October 2017, a South African Parliament multi-party delegation led by the former Deputy Speaker Honourable Lechesa Tsenoli embarked on a study tour to the Denmark Parliament (Folketing) including the Danish Board of Technology and the then Department of Science and Technology (DST), now known as the Department of Science, Technology and Innovation (DSTI). Denmark boasts of having one of the best Information and Communications Technology (ICT) infrastructures in the world. To give impetus and expression to the lessons learned from the Denmark Study Tour, Parliament hence proceeded to host a roundtable discussion on the 4IR on 31 May 2018.

This inaugural roundtable discussion was positioned as a launching pad to a series of high-level engagements of leading agencies and institutions, with the strategic intention of gearing South Africa towards optimising the benefits of the 4IR, while mitigating the inherent risks and challenges before us. The main purpose of the roundtable discussion was for Parliament to set the tone for further engagements, focusing on the most crucial choices confronting South Africa on how the 4IR will influence the development trajectory.

Stemming from the first 4IR Roundtable discussion held on 31 May 2018, Parliament continued its commitment to engage in public dialogue to explore opportunities further and address any threats that may be associated with the 4IR. These engagements included various 4IR public awareness campaigns, Expos, roundtable discussions and webinars, amongst others. Subsequently, since the launch of the 4IR roundtable in 2019, there have been various commitments to “4IR” initiatives including Committees of Parliament with the mandate to conduct oversight over the Executive implementation of the “4IR”. This included numerous 4IR initiatives, including roundtables, expos and awareness campaigns. In 2023, the Office of the Deputy Speaker, in collaboration with the Portfolio Committee on Higher Education, Science and Innovation, embarked on a joint venture to celebrate young innovators through a series of initiatives to showcase youth innovation. This took the form of an EXPO

¹ Parliament of RSA (2018; 2019).

where innovators could showcase their innovations. The ongoing partnership with the Council for Scientific and Industrial Research (CSIR), focusing on 4IR-related work in various forms, remains critical to the success of such initiatives.

3. DISCUSSION

The Education and Recreation Cluster in the Parliamentary Research Unit (PRU), in collaboration with the CSIR, hosted a webinar on 5 May 2025. **The theme was: The Impact of 4IR on the Education Sector.** The PRU is a unit within the Knowledge and Information Services (KIS) Division, Parliament of the Republic of South Africa ("Parliament"). A total of 214 participants attended the session.

3.1 Welcome and introduction

Dr Esethu Stofile was the facilitator for the session. Dr Stofile is the Chief Education Specialist: eTeaching and Learning at the Eastern Cape Department of Education. He introduced the discussion with a short background and located the discussions on the 4IR within the context of the work of Parliament. Dr Stofile officially welcomed participants and unpacked the key tenets of the impact of 4IR technologies on the education sector.

Parliamentary researcher, Mr Lindinxiwa Mahlasela, introduced the presenters.

3.2 Introductory remarks

The introductory remarks were delivered by Dr Esethu Stofile. Dr Stofile noted the following initiatives from the Eastern Cape Education Department:

- The strategy in the Eastern Cape is to ensure that everything done is to leapfrog inequalities and the digital divide, amongst others.
- There has been a commitment in the Eastern Cape province to ensure that there is a lot more investment in terms of the digitisation of systems.
- The primary focus is transforming teaching and learning methodologies by exploring E- pedagogy. In other words, to what extent are teachers empowered to teach learners through the teacher development unit?
- There is also a commitment to promote critical thinking skills, information and literacy. As such, there is a comparison between provinces, because all provinces follow the same e- education strategy that has been gazetted by the Department of Basic Education (DBE).
- It should be noted that the Eastern Cape have a unique ecosystem, i.e. rural schools. As such, part of the investment in e-technology is to reach the most remote communities where there is no connectivity. A hybrid approach is adopted with online and offline capabilities.
- The Eastern Cape Education Department built a studio in East London, with live streaming of lessons. In addition, there is curating and editing of videos that is localised so that schools, even in the rural areas, can benefit from some of the lead teachers in the province. There is a commitment to build a robust digital education ecosystem by working collaboratively with the curriculum directorate.

- Most of the technical expertise is internal, with limited outsourcing of services.

3.3 Presenters' perspective

A. Dr Nkosinathi Sishi: Director-General (Department of Higher Education)

Dr Sishi is the Director-General at the Department of Higher Education. Dr Sishi indicated that there are 26 public universities, 134 private universities, 50 public colleges, 180 private colleges, 9 community colleges and 21 SETAs. As such, the impact of the 4IR may not necessarily be the same in every sector of higher education.

Furthermore, Dr Sishi noted that the sector continues to be faced with inequalities that were inherited by the PSET system. This will determine the context in terms of impact in each of the sectors of higher education. The contribution to the 4IR in relation to research and innovation is significant.

The DG's presentation provided an overview of how the PSET system is adapting to the demands of the 4IR, with a focus on how policy, institutional capacity and systemic collaboration are being leveraged to transform teaching and learning as well as skills development in the country.

It was noted that the Department of Higher Education is the lead department when it comes to skills development in South Africa. DHE is planning a skills summit where they are going to be tabling the Revised HRD strategy as well as the Master Skills Plan for the country.

The white paper on Post-school Education and Training was published in 2013, which remains the foundation stone for the sector transformation. It envisions a fair, inclusive, and responsive system. The national plan for post-school education and training would then seek to operationalise this vision. Promoting the expanded access to post-school education and training workplace, alignment as well as the adoption of flexible technology and able delivery modes, all of which are critical for a driving sector, the higher education and training system.

With 343 colleges and 158 higher education institutions. The PSET system has a wide reach and persistent inequalities, and limited digital capacity. Priority areas will include digital learning environments that will include the reskilling of lecturers, curriculum reform and fostering entrepreneurship, building foundational and competency-based skills, such as creativity, collaboration, and problem solving are critical in the sector and become more agile in operational models.

Skills such as digital literacy, numeracy and literacy are foundational in this sector in an evolving labour market, and cognitive agility will define employability. The sector is aligned, and it must continue to improve in this area of teaching and learning to foster adaptability, flexible mindsets by ensuring that lecturers and students have skills such as critical thinking, creativity, collaboration, effective communication and understanding of different cultures and working in a connected environment.

The ministerial task team on the 4IR, appointed and established in 2019, assessed the readiness of our sector to implement this. These innovations have informed critical initiatives that the Department embarked upon, such as the curriculum reviews that we've done, skills,

alignment, and collaboration with the Department of Science and Innovation and many other departments, sport, arts and culture, are some of the departments that have a role to play in education as well.

Its goal is to ensure that PSET institutions are well-positioned to function effectively in a rapidly changing environment. Its purpose was to investigate the capacity of the PSET system. The ministerial task team was set up to embrace the affordances of the 4IR, provide the skills that are in line with the needs for the 4IR and contribute to the 4IR through research and innovation. Embracing the affordances of the 4IR will imply that connectivity across our institutions has improved through partnerships with many of our, you know, partners, especially in the private sector.

These infrastructure efforts are foundational to expanding online learning. DHE is working with partners to ensure that long-term and sustainable digital access across the system, particularly in rural and under-resourced areas. One of the major initiatives is the centres of specialisation and centres of excellence, and AI integration. In this regard, these centres are being established, especially in TVET colleges, with support from industry partners like Intel, the ETDP SETA, one of our entities, MerSETA,

On transforming, teaching and learning, the DHE is driving a shift towards online blended and multimodal learning across all institutions. This includes digital content development. It includes lecturer support systems as well as open access to digital learning resources through platforms such as the national open learning system (NOLS). These reforms support inclusive and flexible learning pathways. The DHE would like to have had more students accessing the knowledge systems. Progress is noted where more students can access these systems, and thus, there will be benefits of the innovations initiated.

Institutions are reviewing their curricula currently to reflect emerging skills demands. This includes inter- and multidisciplinary approaches that prepare students for new and evolving occupations, many of which do not yet exist.

The medium-term expenditure framework has outlined growth targets that include that DHE seek to increase the number of TVET colleges that are offering 4IR-aligned skills from 10 to 50. The Department seek to scale the digital training for lecturers from 400 to 6,000. These are targets that reflect systemic reforms, but also our determination to not just implement, but to improve access, because physical access is not enough.

Quality or access to quality is the biggest goal and would be possible only through strengthened partnerships. In this regard, the TVET curriculum is being modernised through the inclusion of robotics and other 4IR technologies.

Collaborations with GIZ and others are introducing modular and workplace-relevant learning that integrates technical, digital and green economic skills. The department is supporting flexible learning through short courses and investigations. DHE is supporting flexible learning through short programs and investigating the use of micro credentials, and these are valuable for upskilling and reskilling in a dynamic economy. The goal is to produce more than 30,000 artisans annually, which is aligned with the needs of our industry and society.

Skills development is a critical output, especially in private colleges. Sponsorship by industry, including SETAs, is the 4IR centres of excellence, intended to support upgrading of training facilities, workshops through the acquisition of tools and equipment that are related to the 4IR. Capabilities and facilities will be enhanced to provide students with training and equipment, so that lecturers have improved capabilities in terms of the required pedagogies that provide or is provided through online teaching and supporting of students.

Universities have also contributed significantly in this regard, and their role is well published, and their contribution to the 4IR in the space of research and innovation, particularly by initiatives led by Wits University, where there are several projects already, playing in the space and where the emphasis is on transformative tech for healthcare and some of the vets, big data projects which includes, exploring some of the human rights, ethical and moral questions pertaining to robots and sentient beings, television pay station providers like Multichoice South Africa and the University of Pretoria. They have announced partnerships to develop and sustain scarce artificial intelligence and specifically machine learning technology skills in the country through sponsorship of a research chair in machine learning at the University. Moreover, Innovation transformation at the University of Johannesburg and its partners has extended to Google Maps.

Through these universities, the sector is exploring data science and AI to improve student success tools that predict academic performance, and that can guide interventions and reduce dropout rates and support evidence-based planning across institutions.

The 4IR offers the Post-School Education and Training (PSET) sector a rare opportunity to reinvent itself by embedding digital literacy, encouraging innovation and fostering public-private collaboration. It is possible to bridge inequality and ensure relevance through strengthened partnerships and improved collaboration.

Dr Sishi concluded by stating that work should continue to ensure that investments, commitment and policy coherence are achieved. Embracing the affordances of the 4IR is no longer optional. It is critical for the future of the education system and society, and initiatives such as this webinar continue to strengthen efforts in this regard. As such, the time to act is now. Education in the 4IR is not just about technology, it is about transformation, it is about access and the future of our society.

B. Mr Ashric Don: Deputy Chief Education Specialist: Coding and Robotics (Western Cape Education Department)

His theme was ***"The Impact of 4IR Technologies on the Education Sector: From Policy to Classroom Implementation"***

Mr Don focused on the shift from 4IR to 5IR by bringing 21st century skills into all classrooms. He noted that coding and robotics are already a gazetted subject which addresses many of the 4IR core skills that we are currently facing.

By 2030, at least 85 per cent of jobs will need digital skills. Automation, AI, and robotics are not just changing jobs, but reshaping South Africa's compete, and if slow to act, there is a risk of preparing learners for a world that no longer exists. There is thus a need for paradigm shifts

with new ways of learning.

Before, it was about teaching facts and theory. Now, there is a need to teach learners how to think, solve problems and create. Coding and robotic shift learning from passive memorisation to real-world problem solving. Other countries are already embedding AI literacy, coding, robotics, and computational thinking from Grade 1 to 12. There is thus an urgency to move from pilot to policy to practice.

Looking at the coding and robotics curriculum in the 3 core strands, which are coding, robotics and digital concepts. The 3 strands touch on 4IR and 5IR. The core competencies that learners need are logical thinking, problem-solving, computational thinking and design thinking. These are not just technical skills; they teach resilience, creativity. Coding fosters problem-solving and innovation. AI literacy should thus be considered a foundational skill alongside coding and robotics to stay abreast with the rest of the world.

Computational thinking is vital for problem-solving because you learn to decompose, identify patterns, apply abstraction and create an algorithm, a set of steps. Coding skills teach the creation of software and apps, and robotic skills. These skills become prevalent within computational thinking. Learners need to solve these kinds of problems and then build on that, including AI skills, which is where algorithms come in.

In June 2024, coding robotics was gazetted as an official subject. This year, 2025, the Western Cape Education Department is piloting this curriculum, including the adoption of a blended model in terms of training. Implementation is set for 2026 for the Foundation Phase (Grade R-3). The emphasis is on unplugged coding, which revolves around problem-solving. From 2027 to 2032, there will be a gradual implementation process. Collaboration with NGOs and other service providers in the ecosystem is thus critical.

There is extensive training offered across multiple levels from classroom educators, including officials. There is also a focus on lead teachers preparing to decentralized training for more reach. In addition, there is also the integration of coding, robotics and STEM, including centres of excellence. There are various projects and initiatives, including competitions and tournaments on coding and robotics.

In terms of skills and jobs for the future, it is anticipated that by 2030, about 170 million new jobs will be created globally, offsetting about 92 million of these jobs, equity and inclusion. Successful implementation requires adequate resourcing and infrastructure, including the training of teachers. Collaboration and partnerships across sectors are thus critical to achieving success within the 4IR arena.

Key points:

- **Curriculum Transformation:** Shift from content-based education to competency-based education. Implementation of Coding and Robotics as a Gazetted subject (June 2024). Phased rollout strategy: Grades R–3 (unplugged), Grades 4–9 (technology-integrated).
- **4IR Technologies in Education:** Robotics, IoT, Coding, AI-driven learning management systems (LMS), big data analytics. Current technology integration

successes and infrastructure needs in schools.

- **Addressing Educational Inequality:** Initiatives to bridge the digital divide: unplugged coding activities, rural school interventions, strategic public-private partnerships.
- **AI Literacy and Readiness:** Importance of AI education for both learners and educators. Ethics, responsible use, and integration strategies for AI in classrooms. Cybersecurity Risks and Strategies. Identification of key risks: data breaches, online safety, and cyberbullying. Recommendations for cybersecurity education and school policy frameworks.
- **Leveraging Big Data in Education:** Applications of data analytics to enhance learner tracking, performance evaluation, and early intervention strategies. Ethical considerations, data privacy, and management practices.
- **Future Skills and Job Readiness:** Preparing learners for future careers influenced by AI, robotics, and digital innovation. Importance of developing entrepreneurial and critical- thinking skills.
- **Teacher Professional Development:** Strategies for ensuring educator readiness through ongoing training, PLCs, and higher education institution collaborations.

3.4 Panel discussion

The CSIR played a video which demonstrated the opportunities 4IR technologies can bring. The video centred on skills development for the 4IR. It explored the future of industrial work at the CSIR Learning Factory.

The 4IR is the digital transformation of manufacturing production and related industries. It is a new way of organising and managing industrial value chains. It has heralded the transformation of entire systems of production, management and governance. Digital transformation has also caused the transformation of the skills landscape, and we must empower our workforce to access the requirements and opportunities that this transformation brings to support South African industries and the broader workforce, which includes the youth and unemployed, to participate optimally in the opportunities embedded in the 4IR. The CSIR has established a learning factory with the express aim of driving skills development in those disruptive technology domains that are the building blocks to advance manufacturing and future production.

The digital transformation themes include the Internet of Things. Digital lifecycle management, augmented reality for supplementing human operation, integrated automation and robotics, additive manufacturing, smart systems for smart infrastructure, cyber security, big data analytics. Simulation, cloud computing and edge processing training is multi-model, some online, some a hybrid of virtual and hands-on and caters for varying levels of technical competence requirements.

The customizable learning path spans theoretical concepts, practical engagement with the various technologies, creation of the technologies to control industrial scenarios and experiencing the use of the technologies in real production environments. Master site of the learning factories fitted with different workbenches for the different learning activities. Locally sourced technologies are used as far as possible. This includes state-of-the-art infrastructure for smart manufacturing, human-centred automation, collaborative robotic systems, augmented reality platforms and a smart house scenario. The modularity of the learning factory allows access to additional equipment and facilities distributed across the CSIR as well

as in industry across the country. Other facilities at the CSIR that are also accessible include the photonic centre with 3D printing platforms like AeroSwift, which are being developed.

Other examples are in the chemicals cluster, where we are supporting the Biomanufacturing Industry Development Centre with the application of 4IR technologies. Another key module is the casting technology centre, which supports industry in the optimisation of casting processes. The CSIR foresees that the learning factory will be used by technologists and engineers, but also trainers who need to pass the learning to others because the content is at different levels and in different themes. Participants can select specific modules. They can join onsite or do the work at their own pace online.

It is the CSIR's way of supporting South African industry and the knowledge or knowledgeable economy. The first curriculum was rolled out in early 2022 and was flooded with inquiries and enrolments. This was an indication of the need for more skills development on the 4IR technologies. The course curriculum is presented in different modules to cover topics such as the 4IR and industry, 4.0 technologies of industry, 4.0, that enable human-centred automation application areas within various industrial sectors, as well as challenges and opportunities.

In the South African context, training content is being continuously expanded, based on industry, needs and technologies already covered include aspects of artificial intelligence, augmented reality, robotics, additive manufacturing the Internet of things, big data, analytics, cloud computing and edge processing system integration digital twinning, simulation and cyber security.

Dr Belinda Matebese noted that the CSIR Learning Factory is dedicated to bridging the critical gap between academic knowledge and real-world application in advanced 4IR technologies. While our core focus is on bridging the gap between higher education and industry, we recognise the paramount importance of end-user (existing workforce) and early (youth) exposure to 4IR concepts and technologies.

To this end, we offer a range of resources, including Mobile Learning Factories, designed to reach schools and underserved communities. These mobile units serve as powerful outreach tools, introducing students to hands-on experiences in artificial intelligence, robotics, additive manufacturing, and more, ensuring that even in remote locations, individuals have the chance to engage with these technologies. This early exposure not only sparks interest in STEM fields but also helps students explore potential career paths in the 4IR landscape. By providing practical, industry-aligned training and fostering collaboration between academia, industry, and government, the CSIR Learning Factory is committed to building a more inclusive and future-ready South Africa.

Ms Gabi Immelman encouraged Parliament to consider an agenda focused on progress and innovation, one that sets bold targets, funds youth-led ventures, builds sandboxes for responsible experimentation, and celebrates ambition alongside inclusion and shifts the frame:

- From risk mitigation to opportunity creation;
- From slow consensus to fast experimentation; and
- From oversight-first to builder-first.

The current framing of 4IR in the concept document is cautious, primarily defensive, and risk oriented. While understandable, this posture is unlikely to deliver the accelerated progress and economic transformation our country urgently needs. South Africa has the talent, resources, and institutional knowledge to lead the 4IR. Ms Immelman encouraged everyone to move towards student-centred pedagogies and methodologies that are rooted in student motivation and agency.

Ethical considerations are critical in the 4IR arena. However, ethics is a complex question, especially in a context like South Africa, where we have lots of people from different backgrounds and different realities. Whose ethics? To what end? A lot of the debate is rooted in the idea that ethical use of AI is not to use AI for plagiarism, which may be time-consuming. To police the use of AI would be challenging, especially given the vast extent to which students use AI using WhatsApp or TikTok. Societal questions to consider are what things do we want humans to do, and what things do we want machines to do on our behalf?

Is AI a moral question or an ethical question, which is, what are we doing to make sure that our young people do not feel that they do not have a purpose, or that there is no reason to learn anything? In a world where machines can do what we can produce outputs that are indistinguishable from human output. That's the big societal question we need to grapple with and make sure that we're engineering communities where young people feel purpose and motivation to leverage technologies and tools. And to want to contribute to society.

Mr Henry Kavuma stated that in terms of DBE policy and legislation would enable the Department to leverage on technology and improve the quality of teaching and learning, or improve the quality of services provided by the Education Department. There is a policy in place, which is the white paper on e-education that was developed in 2004. Now with the new developments and emerging technologies which have come up over time and the various policies from the different departments, as well as the UN, there is a keep pace with that.

As such, the DBE recognised the need to develop a new policy that speaks on how to leverage technology in education generally, and how to leverage digital technologies to improve the quality of education. Mr Kavuma noted that since it takes time to develop a policy, the DBE drafted a comprehensive strategy, namely the digital education transformation strategy. This strategy is aimed at leveraging technology and transforming basic education in various aspects, not just teaching and learning, but in various aspects in terms of administration, in terms of how we administer our examination and assessment in terms of teaching and learning. The objective is to develop digital citizens who can navigate the digital era and be productive not only as consumers but also as producers. The draft strategy is near completion, yet to be submitted for approval and implementation.

Other initiatives have been undertaken by DBE, including the introduction of the 3-stream model, which offers diverse learning pathways including academic, vocational and occupational pathways.

The DBE, in collaboration with various stakeholders, developed guidelines which speak on E-safety. This whole initiative has been developed in partnership with various stakeholders. The other aspect in this regard is the issue of digital competencies. Each technology is not going to be treated on its own, but the approach is comprehensive.

The approach will include digital ethics, i.e. cyber safety and the cyber safety. This is covered under digital competencies in pedagogy, as teachers are using technology in teaching and learning. Teachers integrate into the curriculum.

4. THE WAY FORWARD

Dr Jakobo Jacob Moroe, Researcher, Parliament of RSA, summed up the way forward and thanked the participants. Dr Moroe emphasised that discussions were rich and may inform legislative reviews, resource allocations and oversight mechanisms that prioritise future education systems in South Africa and Africa at large. The rich discussions during the webinar ignited several topics that will be addressed in future 4IR webinars.

4.1 Key recommendations emanating from the webinar

The dialogue must inform practical outcomes, focusing on the following key pillars:

- Policy review, Parliament must proactively initiate and accelerate the review of education-related legislation to ensure that it is fully aligned with the demands of digital transformation and equitable access to learning technologies.
- Public-private partnerships are critical.
- Government departments should actively explore collaborative partners with key private sector and civil society in efforts to bridge the gap with respect to the digital divide, especially in under-resourced or remote communities.
- There should be a focus on AI and digital literacy. Targeted investments are needed to ensure that learners and educators are adequately prepared to integrate AI into learning environments.
- Capacity building is pivotal as educators must be equipped through structured training and continuous development programs to integrate emerging technologies into classroom practice effectively.
- One of the outcomes that emerged from this dialogue is also curriculum transformation.
- Robotics and coding must be systematically integrated into the national curriculum from the foundational phase, underpinned by comprehensive teacher training programs and sustained investment in digital infrastructure.
- Ethics continue to be critical in the 4IR arena.
- Role of government in terms of policy framework, developing clear policies is fundamental within the 4IR.
- Funding and investment are key to supporting collaborative initiatives.
- Research and development are critical in addressing challenges within the 4IR.
- Connectivity and infrastructure development to ensure equal access.
- Skills development is pivotal to ensure adequate capacity within all sectors to navigate the 4IR to enhance all sectors.
- Effective oversight is critical to ensure the regulation of 4IR initiatives within all sectors, especially when it comes to ethical considerations with the use of 4IR technologies such as AI.
- There should be an alignment between the education sector and industry to ensure that students are adequately equipped for future jobs.

- There is a need for quicker turnaround for revised 4IR curricula to keep up with the pace at which technology rapidly evolves.

5. CONCLUDING REMARKS

The 4IR has impacted all sectors of society, especially with the onset of the Coronavirus Disease 2019 (COVID-19) pandemic. COVID-19 brought drastic changes to face-to-face teaching and learning in four-walled lecture halls, and inequality among countries, institutions, and students, which was unveiled and exposed. For example, the COVID-19 pandemic has compelled educational institutions across the world to change from traditional pedagogies of curriculum delivery to digital platforms and has thus been a catalyst for the 4IR.

The anticipated impact that 4IR will have on society has laid the platform for South Africa and the rest of the African continent to embrace the opportunities presented and develop a shared 4IR vision for Africa. The posed challenges are becoming unique opportunities. Especially whereby current and future technologies are leveraged and the potential threats mitigated. Achieved by ensuring a cohesive and comprehensive national response involving the citizenry and prioritising the key areas of focus in developing policies, laws and programmes of action.

The inequalities during the pandemic were evident as historically disadvantaged institutions and sectors continued to experience technological, infrastructural and staff capacity limitations. The lack of suitable infrastructure and access to technology can cause some constraints for the successful integration of remote conditions. Challenges include access to digital devices such as laptops and data, digital literacy training, and connectivity, among others. Inequalities remain a huge challenge across all sectors of society. However, while challenges do remain in the system, South Africa has made many strides in the 4IR landscape. The 4IR conversation is becoming rigorous, and it is acknowledged that there is a need to redefine this phenomenon to suit our context.

Parliament thus maintains its vision of an activist and responsible People's Parliament devoted to improving the quality of life for all citizens. As the highest public political institution in the country, our contribution to truly representing the people will be to contribute to taking action to close the inequality gap. Parliament, therefore, has an obligation through its oversight functions to facilitate proactive oversight over the implementation of the Executive's priorities. It is thus imperative that Parliament create a regulatory and enabling environment by developing a 4IR legislative framework to ensure that effective oversight is conducted.

6. REFERENCES

- World Economic Forum (2017).
- Parliament Roundtable Report (2018).
- Parliament Roundtable Report (2019).
- Parliament Webinar Report (2022).
- Parliament Webinar Report (2025).

APPENDICES

Appendix A: Findings and recommendations from previous 4IR initiatives

Below is an overview of key findings and recommendations that emanated from 4IR initiatives such as the roundtable discussions and webinars.

FINDINGS	RECOMMENDATIONS
Roundtable 1: 18 May 2018	
- Some departments have initiatives on the 4th IR. - Department of Science and Technology (DST) - Department of Trade and Industry (DTI) - Department of Higher Education and Training (DHET) - Department of Economic Development (DED) - Department of Labour (DOL) - Department of Basic Education (DBE) - Industrial Development Corporation (IDC) - Technology Innovation Agency (TIA) - An Inter-ministerial task team has been initiated. - Lack of co-ordination and integration across spheres and sectors.	- Adopt an integrated approach and develop a National Strategy on the 4th IR. - Consolidate the Inter-ministerial task team. - Presidential Advisory Council as a focused approach towards the development, production, uptake and usage of cutting-edge technologies throughout the economy, taking into account the possible negative consequences on employment and job creation. - The proposed Advisory Council shall commission high-level research, international and regional benchmarking, and engage stakeholders within and outside government in meetings and other fora to obtain and consider the views of a cross-section of societal role players in the development of the Fourth Industrial Revolution National Action Plan. - A National Blueprint is recommended to regulate the 4IR. - Public-private partnership model is required to create an innovative and competitive manufacturing ecosystem. - Consultative process, being initiated by Parliament.
Roundtable 2: 19 February 2019	
- Rapid organisational change that 4IR is creating in not only organisations but also society and legislatures - The future of regulation in relation to Adaptive regulation, Regulatory sandboxes and greenhouses, Outcome-based regulations, One-size fits all scenario and Collaboration. - Regulation to date has been largely based on a one-size-fits-all model, and with the advent of digital technology, one-size-fits-all does not fit all. 4IR strategies mainly focus on technology and the digital landscape.	- A paradigm shift is required across sectors and Organisations to understand how 4IR technology, such as the internet of things (IoT), and AI, can improve the work at grassroots level. Adaptive regulation: Agile government requires adaptive regulation. Due to the high level of complexity, appropriate agile governance, regulation and decision-making require a systems approach Regulatory sandboxes and greenhouses: There is a role for legislatures and policymakers to

FINDINGS	RECOMMENDATIONS
• Awareness and understanding of 4IR are one of our main themes of the digital industrial policy. • Members of Parliament (MPs) need to understand the implications of the 4IR and what responsibility it confers in relation to oversight and the key role of MPs in communicating important issues to the public. • An ageing workforce • Industrialisation vs Automation • Commercialise innovation and protect intellectual property rights • The current education system (both pedagogy and the content in its current state) does not support 4IR. • Teacher-centred and learner-centred methodologies are not adequate • It takes at least 2 years to change a curriculum • There is a need to establish strategic partners • Data bias: There are limited African databases. The systems are trained with data that is available, and most of the existing data does not come from Africa • Limited public access to data ◦ There is a lack of data ownership • Cybersecurity is critical since initially the internet was developed with a focus on connectivity and not security. A similar trend is emerging with the 4IR. • The focus on Science, Technology, Engineering and Mathematics (STEM) must change to Innovation, Science, Technology, Engineering, Arts and Mathematics (ISTEAM).	encourage regulation to create these sandboxes and greenhouse environments • Outcome-based regulations: Include regulations do not determine the technical inputs by technologies that are being applied here, but are driven by the outcomes • One-size fits all scenario: Regulation needs to reduce red tape, and an application of a regulatory framework is required that is risk-weighted and allows small start-ups to be able to scale their solutions in a safe environment. • Collaboration: National and international collaboration is necessary and explore the integration of Africa into the 4IR space. • Create research capacity to develop a strategy for the digital and industrial economy. • Introduce a social compact and include the human aspect in strategies. • Political commitment is required, including the review of mandates ◦ Review of policy coherence and alignment when exploring the development of systems for connectivity. • Design and implement information and awareness programmes to discuss and have policy dialogues on 4IR. • There is a need to explore the self-regulatory dimensions of all of this as it relates to ethical decision-making to enhance a good/responsible citizenry. • Africa has a younger population, and there is a huge opportunity for the world to invest in the young people of Africa and do skills development • There is a need to look at jobs in relation to industrialisation and automation • Not only focus on research-based innovation that is being commercialised, but also explore solutions introduced by industry and commercialising that together with protecting the intellectual property rights

FINDINGS	RECOMMENDATIONS
	• There is a need for curriculum reform/change in the existing curriculum development • There is a need for learner-led methodologies, i.e. 5Cs ◦ Critical thinking, collaborating, creativity, communication skills, computational skills. ◦ Simulations; and ◦ Coding programmes. • Create an enabling environment for innovation. • Partnerships with a shared 4IR vision are required to include social and human scientists. ◦ Country-wide, cross-sectoral plan of action is required, including academia, industry, and civil society. ◦ Africa must participate in global data creation spaces. • Social media can be used to collect data ◦ Policies required to deal with data ownership include encrypting data. • From the outset, there should be a focus on security aspects relating to 4IR. • It is pivotal to include the creative industry in technology development to ensure a holistic enabling environment that embraces the needs of industry and society.
4IR Webinar: April 2022	
• Inadequate provision of robotics kits; the introduction of this new subject into an already full curriculum presents timetabling problems. • Inadequate training of teachers, and the challenges brought using robotic systems, as these are costly, require internet connectivity and are sometimes too unwieldy for the larger classroom setting. • The downsides of 4IR may include deepening existing inequalities and widening the gender gap. • Find local solutions for local problems. • Prepare learners in the Post-School Education and Training (PSET) system for an uncertain future, and the need to foster creativity and	• Government and Parliament to ensure an adequate budget is appropriated to successfully implement the 4IR. • The PSET sector to continuously review and implement a curriculum needed to create an enabling environment that contributes to the 4IR. • The high costs associated with accessing information need to be addressed by the Government through relevant partnerships with the private sector. • Government should place a special focus on the marginalised and rural areas. • Government and relevant stakeholders should support the work of local creatives, innovators and creators who, through their

FINDINGS	RECOMMENDATIONS
'mental elasticity' to ensure the creation of something valuable for society. • All institutions must produce competent students who can then enter the job market upon exiting their studies. • Interrelated subsystems include technology-enabled learning environments, accreditation and certification; teacher/learner reskilling; curriculum relevance and competency skills; ecosystem agility and redesign; entrepreneurship; industry linkages and relationships; and decent work. • The importance of the humanities and social sciences in developing the emotional intelligence, creativity, writing and communication skills required to thrive in a "4ir workplace". • Key departments are driving the 4IR from the executive perspective. As such, budgeting is influenced by what projects and plans these key departments will implement. • Within the rural setting where infrastructure, development and load shedding present challenges to accessing coding, robots and internet connectivity, a specific rural strategy framework should be developed to guide the advancement of computer skills, internet usage, wireless internet and the cost factor. • Technology exists for learners to learn in an online environment, in a place where there is no internet connectivity. • Basic and Higher Education and Training curricula must be revised. • Need for teachers to receive adequate training in the pedagogy and methodology for teaching Coding and Robotics. • A need for teachers to transform their teaching to teaching in a play-based environment and employ a problem-based methodology. • There is a need for skills development in the education sector. • The COVID-19 disruption highlighted how unprepared the education system was for the 4IR. It further underscored the level of inequality in the sector, access to infrastructure, and equipment.	localised solutions, contribute to the reduction of costs associated with the implementation of the 4IR. • Due to the speed at which the internet of things is developing, Government should ensure that no learner or teacher is left behind through continuous improvement of competency and foundational skills. • Parliament to develop systems to ensure that there is a deeper engagement with the public on the research and innovation underway in the PSET sector, as well as the implications of the 4IR on labour and employment. • Government needs to fast-track the rollout of digital infrastructure that facilitates access to information, enhancing transparency and building interconnected communities. • Government and Parliament to continue their efforts to review, amend or create policy and legislation that supports the successful implementation of the 4IR. • Government and stakeholders should use the COVID-19 disruption as a lesson to evaluate their current initiatives within the education sector and reinforce the need for creating an adaptable workforce that approaches learning as a continuous process. • Government should place a special focus on the marginalised and rural areas. • Extensive training of officials, and research and development of more affordable robotics kits, accompanied by teacher guides. • Collaboration across key directorates within the department. • A dedicated educational network to facilitate interconnectedness, which encompasses finding a long-term solution to introduce zero-rating on all access to local content; a strategy for expanding online learning for PSET; various infrastructure initiatives; open, i.e. free educational resources; curriculum and programme review; and skills development and capacity building.

FINDINGS	RECOMMENDATIONS
	• The strategic placement of the National Advisory Council on Innovation (NACI) within Government, particularly the Presidency, to ensure that all Government Departments have a directed focus on the implementation of 4IR. • Different solutions are required within the South African context, particularly when the inequalities of economics and geographical spaces are taken into consideration. • Universities to include robotics in the programme of students of education to ensure they enter the job market already armed with these skills. • HEIs to explore offering recognised short courses, which carry credits, in coding to teachers so these courses can be regarded within the system of Recognition of Prior Learning (RPL). • Adequate, deep training of teachers through ongoing short courses throughout their careers is essential to keeping teachers current in the implementation of 4IR in the curriculum. • These are thus issues that need to be addressed through discussion and appropriate budgeting for all relevant sectors, particularly education and science, to ensure equality.
4IR Webinar: 17 February 2025	
• 4IR technologies raise fears of job displacement due to automation and AI, the unequal distribution of technological benefits, and the widening of existing economic disparities. It increases the risks of cybersecurity threats that jeopardise privacy and security. It also raises ethical concerns about AI and surveillance misuse. • Regulatory challenges are also becoming widespread as laws have been unable to keep pace with rapid technological developments. Our lack of digital infrastructure and necessary skills further exacerbates these risks. • In South Africa, although certain activities involving AI are governed by existing legislation, and efforts are underway towards	• Ethics is critical within the 4IR space. • There is a need for government to draft substantive legislation on Artificial Intelligence (AI). • Ethics is critical within the 4IR space. • There is a need for government to draft substantive legislation on Artificial Intelligence (AI). • Government should engage existing regulators on AI matters. • There is a need for a legislative framework that will encompass aspects relating to compliance, monitoring, and innovation. • There should be synergy between the various regulatory frameworks developed

FINDINGS	RECOMMENDATIONS
future regulation, most AI operations remain unregulated. • While the 4IR has positive aspects, a range of discussions highlight the critical need for technology regulation across policy areas. • One of the challenges that needs to be addressed is connectivity and infrastructure.	to deal with the implementation of AI in the country. • Public participation and involvement are critical in creating awareness within the AI space. • An appeal to policymakers to be cognizant when developing a legislative/regulatory framework to not hinder innovation. • South Africa should secure information systems from ongoing threats from other countries and secure our workforce through training programs and regulation of international businesses and how they use AI systems within the country.

Appendix B: Previous findings and recommendations pertaining to the role of Parliament

FINDINGS	RECOMMENDATIONS
Roundtable 1: 18 May 2018	
- Parliament has a key strategic role to play in the 4IR. - Parliament, through its law-making functions, must ensure that an appropriate legal framework is established for the 4IR. - Parliament should ensure evidence-based oversight over 4IR initiatives of the Executive. - Parliament is ideally placed through its public participation function to increase awareness, education and discussion on the 4IR amongst all sectors of society. - Parliament itself should harness the benefits of the 4IR.	- All Members and the parliamentary administration must be fully au fait of the impact of the 4IR on the core constitutional functions of Parliament, i.e. law-making, oversight, public participation, intergovernmental relations, and international relations. - Parliament must prioritise the development of a legislative framework to address the gains and challenges of the 4IR. - Parliament should drive a countrywide process to ensure the appropriate integration across the provinces and local government. - The appropriate parliamentary structures should be identified to ensure coordination and synergy, particularly across and within the four critical sectors (society, industry, business and skills) - Parliament should ensure that broader civil society, such as organised labour, Non-Governmental Organisations (NGOs), the media, etc., is well-informed to engage knowledgeably and meaningfully - The parliamentary administration should adapt its strategy, systems and processes to incorporate 4IR in its support functions.
Roundtable 2: February 2019	
- Parliament, through its public participation functions, must ensure the implementation of a sector-wide information and awareness campaign - Parliament should ensure evidence-based oversight over 4IR initiatives of the Executive - Parliament, through its law-making functions, must ensure that an appropriate legal framework is established for the 4IR. - There is a need to develop policy, legislation and regulations that create an enabling environment for innovation to allow the economy to grow. - Parliament should rigorously drive its 4IR information and awareness campaign to optimise the opportunities emerging within this space	- Parliament should formalise strategic partnerships as part of its 4IR information and awareness campaign. - The appropriate parliamentary structures should be identified to ensure coordination and synergy, particularly across and within the four critical sectors (society, industry, business and skills). - Parliament should prioritise the development of a legislative framework for the 4IR landscape. - Parliament should drive a countrywide legislative process to ensure the appropriate integration across the provinces and local government. - The 4IR requires all stakeholders to be in constant dialogue due to the nature of the

FINDINGS	RECOMMENDATIONS
	technologies that characterise it, and most importantly, this requires Parliament to take the lead. • Parliament should review its internal procedures that govern its constitutionally mandated functions • The parliamentary administration should develop an institutional 4IR strategy that will inform its systems and processes.
4IR Webinar: April 2022	
• Challenge of accessibility, i.e. access to Wi-Fi and social media, in the context of public involvement and how this is mitigated through solutions that include the use of WhatsApp, the provision of data, particularly for citizens living in rural areas, and the use of social media. • The increased use of robotics and digitisation in response to the COVID-19 pandemic has prompted some to argue that this constitutes the onset of the 5IR. • Inadequate provision of robotics kits; the introduction of this new subject into an already full curriculum presents timetabling problems. • Inadequate training of teachers, and the challenges brought by using robotic systems, as these are costly, require internet connectivity and are sometimes too unwieldy for the larger classroom setting.	• There is a need for Parliament (Members and administration) to be swiftly adaptable in this ever-changing landscape. • Extensive training of officials, and research and development of more affordable robotics kits, accompanied by teacher guides. • Collaboration across key directorates within the department. • Need for Parliament to raise the significance of appropriate budget allocation because of the ripple effects of the implementation of the 4IR. • The budget should not merely be thought of in monetary terms, but the potential impact of investing appropriate resources should also be taken into consideration. • The appropriate allocation will ensure better preparedness for the future.
4IR Webinar: 17 February 2025	
• The 2024 <i>AI Index Report</i> from Stanford University finds that there has been a noticeable surge in AI-related legislation worldwide. Over the period from 2016 to 2023, parliaments in 127 countries passed a combined total of 123 bills that reference AI. These regulations cover a range of issues, such as educational reforms, ensuring fairness and non-discrimination in AI algorithms, and setting up AI education initiatives. • The 2020 Report of the Presidential Commission on the Fourth Industrial Revolution highlights key sectors in South Africa where 4IR technologies can be employed to improve services and other outcomes. These include Energy, Water and	• There is a growing acknowledgement of the need for structured regulatory guidelines to oversee the ethical advancement and use of AI technologies. In South Africa, although certain activities involving AI are governed by existing legislation, and efforts are underway towards future regulation, most AI operations remain unregulated. • The legislature needs to be trained to become science literate to implement holistic changes, integrating the specific logics of technologies, the industries they impact, the people who will both consume and produce them and the agility requirements to compete on a global stage."

FINDINGS	RECOMMENDATIONS
Sanitation, Agriculture and Biodiversity Management, Health, and Mining, to name but a few. • The Report also makes recommendations, of which the review, amendment or creation of policy and legislation is one. It states that “the regulatory environment must be adapted to enable the desired progress.	• Parliament remains a key player in ensuring to explore the pitfalls and opportunities and continues to build on them. • Our existence and success as a country are dependent on how well we adapt and adopt these technologies, and at the same time minimise the negative impact on society.