

THE 6TH ANNUAL DHET RESEARCH COLLOQUIUM ON THE FOURTH INDUSTRIAL REVOLUTION (4IR): IMPLICATIONS FOR POST-SCHOOL EDUCATION AND TRAINING



higher education
& training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

Copyright

©Department of Higher Education and Training (DHET), 2019

All ideas, opinions, conclusions and policy recommendations expressed in this report are strictly those of the colloquium participants and do not necessarily represent those of the Department of Higher Education and Training (DHET). The DHET cannot be held liable for any content or syntax errors, or for the accuracy of the information contained in this report.

This publication may be used in part or as a whole; provided that the Department of Higher Education and Training is acknowledged as the source of such information. All information used from this report must be referenced as follows:

Department of Higher Education and Training (DHET) (2019): *The 6th Annual DHET Research Colloquium on the Fourth Industrial Revolution (4IR): Implications for Post-School Education and Training (PSET)*. Pretoria: DHET.

ISBN: 978-1-77018-857-0

All material pertaining to the Colloquium (including speakers' presentations and background papers) are available on the Department of Higher Education and Training's website at www.dhet.gov.za

Enquiries:

The Director: Policy, Research and Evaluation

Tel: +27 (0) 12 312 5297

Email: dhetresearch@dhet.gov.za

**The 6th Annual
DHET Research Colloquium
on
The Fourth Industrial Revolution (4IR):
Implications
for
Post-School Education and Training
(PSET)**



**higher education
& training**
Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

Table of Contents

Copyright	i
Table of Contents	iii
Acronyms	vi
Programme Participants Profiles.....	1
Acknowledgements	5
Background	6
Participation	7
COLLOQUIUM PROCEEDINGS.....	8
A. DAY ONE: WEDNESDAY 18 SEPTEMBER 2019	9
1. Session 1: Opening and Keynote Address	9
1.1. Welcome and Introduction.....	9
1.2. Keynote Address	9
1.3. Opening Remarks.....	12
1.4. Discussion	13
2. Session 2: Understanding the 4IR in the Context of PSET (Panel Discussion)	15
2.1. How are Universities Responding to 4IR?.....	15
2.2. 4IR – Opportunities and Implications for PSET	16
2.3. When the Only Constant is Change: Technical and Vocational Education and Training (TVET) Responding to Changing Workplaces	17
2.4. Discussion	19
3. Session 3: Continental Perspective	20
3.1. Sustainable Development in Africa through the 4IR	20
3.2. Discussion	22
4. Session 4: Implications of 4IR and Learnings (Panel Discussion)	23
4.1. Implications for Qualification Design, Accreditation and Certification	23
4.2. Implications of 4IR for Curriculum Transformation.....	26
4.3. Implications of 4IR for Pedagogy	28
4.4. Discussion	29

5. Session 5: Parallel Commissions	33
5.1. Breakaway Commission A: Skills Supply and Demand in the Context of the 4IR.....	33
5.1.1. Balancing Skills Supply and Demand: A Media, Information and Communication Technologies Sector Education and Training Authority (MICT SETA) Perspective	33
5.1.2. Implications of 4IR for Skills Supply and Deman	35
5.1.3. Discussion	37
5.2. Breakaway Commission B: Using Technologies to Improve PSET	39
5.2.1. PSET as a Digital Ecosystem	39
5.2.2. 4IR as a Driver of the PSET Applications Process Technology	41
5.2.3. Learning Management Systems in TVET Colleges	42
5.2.4. Discussion	43
5.3. Breakaway Commission C: Workplace Readiness in the Context of 4IR	45
5.3.1. Organisational Readiness to Implement the 4IR: A Case Study at Two Local Municipalities	45
5.3.2. Exploring How Work Integrated Learning (WIL) Can Be Used as a Catalyst to Prepare Bachelor of Commerce (BCom) Degree Students for the 4IR: A Case Study of the University of the Western Cape (UWC)	47
5.3.3. The Effect of 4IR on Tertiary Education	47
5.3.4. The Effects of 4IR on Africanisation as an Emerging Global Trend in Higher Education	48
5.3.5. Discussion	49
 DAY TWO: THURSDAY 19 SEPTEMBER 2019	51
6. Session 6: International Perspective.....	51
6.1. Embracing the 4IR: An International Perspective.....	51
6.2. Leveraging Digital Platforms to Accelerate the Creation of Economic Opportunities: Insights from Saudi Arabia.....	52
6.3. Discussion	54
 7. Session 7: How Can the PSET System Respond to Opportunities Provided by the 4IR?Panel Discussion)	56
7.1. The Implications of the 4IR for Skills Supply and Demand	56
7.2. What Kind of Skills, Knowledge and Attributes are Needed to Prepare Students for a Digitised World?.....	58
7.3. Discussion	59

8. Session 8: Can 4IR Technologies Improve Employability? (Panel Engagement withAudience)	61
8.1. Discussion	65
9. Session 9: Report Back and Way Forward	67
9.1 Commission Report Backs.....	67
9.1.1. Breakaway Commission A.....	67
9.1.2. Breakaway Commission B.....	68
9.1.3. Breakaway Commission C.....	69
9.2. Way Forward.....	69
9.3. Social Media Feedback on Engagement	71
9.4. Vote of Thanks	72
Glossary of Terms	73

Acronyms

4IR	Fourth Industrial Revolution
3D	Three dimensional
A/DDG	Acting Deputy Director-General
ABSA	Amalgamated Banks of South Africa
ACO	Ant Colony Optimisation
AfDB	African Development Bank
AI	Artificial Intelligence
API	Application Programming Interface
APPETD	Association of Private Providers of Education and Training and Development
AR	Augmented Reality
ATRs	Annual Training Reports
AU	African Union
Bank SETA	Banking Sector Education and Training Authority
CAO	Central Applications Office
CAPUT	Cape Peninsula University of Technology
CAS	Central Central Application Service
CBOs	Community Based Organisations
CCIE	Cisco Certified Internetwork Expert
CCMA	Commission for Conciliation, Mediation and Arbitration
CEO	Chief Executive Officer
CEPs	Continuous Education Programmes
CET	Community Education and Training
CHE	Council on Higher Education
CHIETA	Chemical Industries Education and Training Authority
COS	Centres of Specialisation
COSATU	Congress of South African Trade Unions
CSIR	Council for Scientific and Industrial Research
DBE	Department of Basic Education

DG	Director-General
DHA	Department of Home Affairs
DHET	Department of Higher Education and Training
DoE	Department of Education
DPRU	Development Policy Research Unit
DRC	Democratic Republic Congo
DSI	Department of Science and Innovation
DUT	Durban University of Technology
ECD	Early Childhood Development
EWSETA	Energy and Water Sector Education Training Authority
FASSET	Finance and Accounting Services Sector Education and Training Authority
FoodBev SETA	Food and Beverage Sector Education Training Authority
FP&M SETA	Fibre Processing and Manufacturing Sector Education Training Authority
GDP	Gross Domestic Product
HEIs	Higher Education Institutions
HR	Human Resource/s
HRDC	Human Resource Development Council
HSRC	Human Sciences Research Council
ICASA	Independent Communications Authority of South Africa
ICT	Information and Communications Technology
INSETA	Insurance Sector Education and Training Authority
IoT	Internet of Things
IP	Intellectual Property
IT	Information Technology
JET Education Services	Joint Education Trust Education Services
LGSETA	Local Government Sector Education and Training Authority
MERSETA	Manufacturing, Engineering, and Related Services Sector Education and Training Authority
MICT SETA	Media, Information and Communication Technologies Sector Education and Training Authority
MIT	Massachusetts Institute of Technology

MOOCs	Massive Open Online Courses
MQA	Mining Qualifications Authority
NAMB	National Artisan Moderation Body
NDP	National Development Plan
NGO	Non-Governmental Organisation
NLRD	National Learners' Record Database
NPHE	National Plan for Higher Education
NPO	Non-Profit Organisations
NPPSET	National Plan for Post-School Education and Training
NQF	National Qualifications Framework
NSA	National Skills Authority
NSC	National Senior Certificate
NSDP	National Skills Development Plan
NSF	National Skills Fund
NSFAS	National Student Financial Aid Scheme
OECD	Organisation for Economic Cooperation and Development
OFO	Organising Framework for Occupations
OpenFn	Open Function Group
PC	Presidential Commission
PE	Port Elizabeth
PhD	Doctor of Philosophy
POPI	Protection of Personal Information
PSET	Post-School Education and Training
QCTO	Quality Council for Trades and Occupations
REAL	Researching Education and Labour
SACPO	South African College Principals Organisation
SADC	Southern African Development Community
SA-SAMS	South African School Administration and Management System
SAQA	South African Qualifications Authority
SARCHI	South African Research Chairs Initiative

SASBO	South African Society of Bank Officials
SDGs	Sustainable Development Goals
SDMX	Statistical Data and Metadata eXchange
Services SETA	Services Sector and Training Authority
SETAs	Sector Education and Training Authorities
SLPs	Short Learning Programmes
SMMEs	Small, Medium and Micro-sized Enterprises
SSP	Sector Skills Plan
StatsSA	Statistics South Africa
STEM	Science, Technology, Engineering and Mathematics
TETA	Transport Education Training Authority
TTRO	The Training Room Online
TVET	Technical and Vocational Education and Training
UAE	United Arab Emirates
UCT	University of Cape Town
UJ	University of Johannesburg
UKZN	University of KwaZulu-Natal
UniZulu	University of Zululand
UP	University of Pretoria
USA	United States of America
USAf	Universities South Africa
UWC	University of the Western Cape
VR	Virtual Reality
VUT	Vaal University of Technology
WBL	Workplace-Based Learning
WEF	World Economic Forum
WIL	Work Integrated Learning
Wits	University of Witwatersrand
WSPs	Workplace Skills Plans

Programme Participants Profiles

- Day One Programme Director: Dr Hersheela Narsee, Acting Deputy Director-General (A/DDG): Planning, Policy and Strategy – DHET
- Session One Chairperson: Mr Gwebinkundla Fellix Qonde, Director-General – DHET
- Session One Presenter: Prof Tshilidzi Marwala - Vice Chancellor and Principal – University of Johannesburg (UJ); and Chairperson of the Fourth Industrial Revolution (4IR) Presidential Task Team
- Session One Presenter: Dr Daniel Adams: A/DDG: Research Development Support – Department of Science and Innovation (DSI)
- Session Two Chairperson: Dr Diane Parker, DDG: University Education – DHET
- Session Two Presenter: Prof Zeblon Vilakazi, Deputy Vice-Chancellor: Research and Postgraduate Affairs – University of Witwatersrand (Wits); and DHET 4IR Ministerial Task Team Member
- Session Two Presenter: Prof Stephanie Allais, South African Research Chairs Initiative (SARCHI) PSET Chair: Skills Development – Wits
- Session Two Presenter: Dr Colin Thakur, Director and Head: e-Skill CoLab – Durban University of Technology (DUT); and DHET 4IR Ministerial Task Team Member
- Session Three Chairperson: Mr Ghaleeb Jeppie, Chief Director: International Relations – DHET
- Session Three Chairperson: Dr Geci-Karuri-Sebina, Visiting Fellow - Wits School of Governance and DHET 4IR Ministerial Task Team Member
- Session Four Chairperson: Prof Aslam Fataar, Vice Dean, Research, Faculty of Education: University of Stellenbosch
- Session Four Presenter: Dr Vidmantas Tutlys, Research and Lecturer: Academy of Education Science – Vytautas Magnus University, Lithuania
- Session Four Presenter: Prof Sarah Gravett, Executive Dean, Faculty of Education – University of Johannesburg (UJ)
- Session Four Presenter: Prof Wendy Kilfoil, Consultant: Department for Education Innovation – University of Pretoria (UP)

- Session Five Breakaway Commission A Facilitator: Ms Mamphokhu Khuluvhe, Director: System Monitoring
- Session Five Breakaway Commission A Scribe: Ms Edzani Netshifhefhe, Deputy Director: System Monitoring – DHET
- Session Five Breakaway Commission A Presenter: Mr Thabang Motsoeneng, Research: Sector Skills Plan (SSP) – MICT SETA
- Session Five Breakaway Commission A Presenter: Prof Babu Sena Paul, Director: Institute for Intelligent Systems – UJ
- Session Five Breakaway Commission B Facilitator: Dr Whitfield Green, Chief Director: Teaching, Learning and Research Development – DHET
- Session Five Breakaway Commission B Facilitator Scribe: Ms Refiloe Mohlakoana, Assistant Director: Policy, Research and Evaluation – DHET
- Session Five Breakaway Commission B Presenter: Dr James Keevy, Chief Executive Officer (CEO) – Joint Education Trust (JET) Education Services
- Session Five Breakaway Commission B Presenter: Dr More Manda, Senior Manager: Strategic Planning – Manufacturing, Engineering and Related Services Sector Education and Training Authority (MERSETA)
- Session Five Breakaway Commission B Presenter: Dr Salamina Dzingwa, Senior Deputy Registrar – Vaal University of Technology (VUT)
- Session Five Breakaway Commission B Presenter: Ms Carol Dwyer, Manager: E-Learning – False Bay Technical and Vocational Education and Training (TVET) College
- Session Five Breakaway Commission C Facilitator: Ms Melissa Erra, Chief Director: Strategy, Innovation and Organisational Performance – National Skills Fund (NSF)
- Session Five Breakaway Commission C Scribe: Mr Simo Zulu, Deputy Director: Policy, Research and Evaluation – DHET
- Session Five Breakaway Commission C Presenter: Dr Harlan Cloete, Extraordinary Lecturer: School of Public Leadership – University of Stellenbosch
- Session Five Breakaway Commission C Presenter: Ms Karabo Moloko, CEO – CoLAB Project Implementation

- Session Five Breakaway Commission C Presenter: Dr Karen Dos Reis, Senior Lecturer and Teaching and Learning Specialist: Faculty of Economic and Management Sciences – University of the Western Cape (UWC)
- Session Five Breakaway Commission C Presenter: Dr Fabian Nde Fon, Ruminant Nutritionist: Faculty of Science and Agriculture – University of Zululand (UniZulu)
- Session Five Breakaway Commission C Presenter: Dr Melusi Sibanda, Lecturer: Faculty of Science and Agriculture – UniZulu
- Session Five Breakaway Commission C Presenter: Prof Nelishia Pillay, Head of Department: Computer Science – UP
- Day Two Programme Director: Ms Trudi van Wyk, Chief Director: Social Inclusion and Quality – DHET
- Session Six Presenter: Dr Marieke Vandeweyer, Labour Market Economist: Employment, Labour and Social Affairs Directorate – Organisation for Economic Co-operation and Development (OECD)
- Session Seven Presenter: Ms Kirsty Chadwick, Group CEO – The Training Room Online (TTRO)
- Session Seven Chairperson: Ms Gerda Magnus, Chief Director: Programmes and Curriculum Innovation – DHET
- Session Seven Presenter: Prof Haroon Bhorat, Director: Development Policy Research Unit (DPRU) – University of Cape Town (UCT)
- Session Seven Presenter: Ms Dianne Woodward, Solutions Design – Harambee Youth Employment Accelerator
- Session Eight Chairperson: Prof Mokong Mapadimeng, Research Director: Education and Skills Development – Human Sciences Research Council (HSRC)
- Session Eight Presenter: Dr Adriana Marais, Founder – Proudly Human; Director – Foundation for Space Development; Faculty – Singularity University and DHET 4IR Ministerial Task Team Member (also aspiring Extra-terrestrial)
- Session Eight Presenter: Mr Louis van Huyssteen, Training Director – Retail Motor Industry Organisation; and DHET 4IR Ministerial Task Team Member

- Session Eight Presenter: Mr Bhabhali Ka Maphikela Nhlapo, Education and Training Secretary – Congress of South African Trade Unions (COSATU)
- Session Eight Presenter: Prof Shireen Motala, Professor: Faculty of Education; and Senior Director: Research and Innovation, Postgraduate School – UJ
- Session Nine Chairperson: Mr Reineth Mgiba, Acting Chief Director: Polity Management and System Planning – DHET
- Session Nine Presenter: Ms Renay Pillay, Director: Policy, Research and Evaluation – DHET
- Session Nine Presenter: Dr Whitfield Green, Chief Director: Teaching, Learning and Research Development – DHET
- Session Nine Presenter: Mr Simo Zulu, Deputy Director: Policy, Research and Evaluation – DHET
- Session Nine Presenter: Ms Trudi van Wyk, Chief Director: Social Inclusion and Quality – DHET
- Session Nine Presenter: Mr Ntokozo Bhengu, Researcher: Monitor and Evaluation – Council on Higher Education (CHE)
- Session Nine Presenter: Ms Rakal Govender, Deputy Director: Policy, Research and Evaluation – DHET

Acknowledgements

The Department of Higher Education and Training (DHET) would like to thank the programme directors, presenters, session chairpersons, commission facilitators, scribes, and delegates for their attendance and participation at the 2019 Research Colloquium. The Department also extends its thanks and appreciation to the following Sector Education and Training Authorities (SETAs) for their sponsorship at the Colloquium:

- Energy and Water Sector Education Training Authority (EWSETA): memory sticks.
- Fibre Processing and Manufacturing Sector Education and Training Authority (FP&M SETA): Colloquium bags.
- Insurance Sector Education and Training Authority (INSETA): Layout, design and printing of Colloquium programme.
- Local Government Sector Education and Training Authority (LGSETA): Gifts for presenters.
- Manufacturing, Engineering, and Related Services Seta (MERSETA): Flights and accommodation for local presenters.
- Media, Information and Communication Technologies Sector Education and Training Authority (MICT SETA): Flights and accommodation for international presenters.
- Transport Education and Training Authority (TETA): Colloquium scribe and proceedings report.

Furthermore, the Department acknowledges the contributions made by the Research Colloquium Working Group members who worked tirelessly to bring the Colloquium to life; the group includes:

- Mr Ntokozo Bhengu (CHE)
- Ms Mahlatse Galane (DHET)
- Ms Rakal Govender (DHET)
- Ms Nompumelelo Hlatshwayo (DHET)
- Ms Angel Mathebula (DHET)
- Ms Nombulelo Kota (DHET)
- Ms Queen Mawela (DHET)
- Ms Refiloe Mohlakoana (DHET)
- Ms Bellinah Molaudzi (DHET)
- Ms Nobakoena Ntoba (DHET)
- Ms Renay Pillay (DHET)
- Mr William Somo (DHET)
- Mr Simo Zulu (DHET)
- Mr Mxolisi Gugushe (EWSETA)
- Ms Linda Mngadi (FP&M SETA)
- Ms Sylvia Tsunke (FP&M SETA)
- Mr Ernest Kaplan (INSETA)
- Ms Josie Singaram (LGSETA)
- Mr Tumelo Ngwako (Services SETA)
- Mr Nkosinathi Gumbi (TETA)
- Mr Mxolisi Maphakela (W&R SETA)

Also supporting at the Colloquium were:

Ms Lindi Mkhize (FP&M SETA), Ms Mmaphake Ramasodi (DHET), Ms Tshidi Chiloane (DHET), Mr Johnny Rachidi (DHET), Ms Pauline Thulare (DHET), Ms Nandiswa Maraba (DHET), Mr Mbuyiseli Dube (DHET), Ms Asavela Siyema (DHET), and Ms Ulandi Thomas (DHET).

Background

On 18 – 19 September 2019, the Department of Higher Education and Training (DHET), together with its entities (i.e. the 21 Sector Education and Training Authorities (SETAs), the three Quality Councils, the South African Qualifications Authority (SAQA), and the National Student Financial Aid Scheme (NSFAS) jointly hosted its annual Research Colloquium on Post-School Education and Training (PSET).

The purpose of the annual Research Colloquium was to deepen the conversation around PSET, amongst stakeholders, by sharing research findings, and promoting research utilisation and dissemination.

The topic *The Fourth Industrial Revolution (4IR): Implications for Post-School Education and Training (PSET)* was proposed because of its growing significance in the PSET landscape. The Colloquium showcased and shared new and cutting-edge research on key dimensions of 4IR, thus providing an opportunity for stakeholders to reflect on policy and practice.

The Objectives of the Colloquium were to:

- Engage with the research being presented.
- Consider implications of the research for policy and practice.
- Identify research gaps in relation to PSET in the context of the 4IR.
- Identify possible solutions and recommendations in relation to PSET in the context of the 4IR.

The Outcomes of the Colloquium were to:

- Contribute towards creating a responsive and enabling PSET system to support the 4IR.
- Promote evidence-based policy making.

The two-day Colloquium was structured in a mix of formal chaired presentations, plenary sessions, panel discussions and breakaway sessions that provided for smaller-group engagements on specific topics including:

- Skills supply and demand in the context of 4IR.
- Technologies to improve PSET.
- Workplace readiness in the context of 4IR.

To date the DHET has hosted six Colloquia and these include the following:

Date	Theme
04 November 2014	State of research on PSET
22 - 23 October 2015	Towards successful Workplace-Based Learning (WBL) in South Africa
29 - 30 September 2016	Skills Planning
12 - 13 September 2017	Enhancing the Implementation of the South African National Qualifications Framework (NQF)
12 - 13 September 2018	Radically transforming Technical and Vocational Education and Training (TVET) Colleges through Empirical Research
18 - 19 September 2019	The 4IR: Implications for PSET

Participation

The Colloquium brought together approximately 250 participants including individuals and organisations from different sectors across education, business, skills and training associations, non-profit organisations, research institutions, and academic institutions etc. Categories of participants included the following:

- Association of Private Providers of Education and Training and Development (APPETD)
- Centres of Specialisation (COS) Programme
- Community Based Organisations (CBOs)
- DHET staff and other Government Departments
- DHET stakeholders and entities (including Sector Education and Training Authorities (SETAs) and Quality Councils)
- Education Portfolio Committee
- Employer Bodies / Business Organisations / Individual Businesses
- International Organisations
- Major Labour Organisations
- Ministerial Task Team Members
- National Council of Provinces (Committee on Education and Recreation)
- Non-Government Organisations / Non-Profit Organisations
- Private Consultancies
- Professional Bodies
- Public Universities
- Research Organisations and Centres at Universities
- South African College Principals Organisation (SACPO)
- Statutory Research Councils
- Student Bodies
- Technical and Vocational Education and Training (TVET) Colleges
- Universities South Africa (USAf)
- University Deans of Education

COLLOQUIUM PROCEEDINGS

A. DAY ONE: WEDNESDAY 18 SEPTEMBER 2019

Programme Director: Dr Hersheela Narsee, Acting Deputy Director-General (A/DDG): Planning, Policy and Strategy – Department of Higher Education and Training (DHET)

Dr Narsee welcomed delegates to the 6th Annual Research Colloquium before introducing the chairperson of Session 1, the Director-General, Mr Gwebinkundla Fellix Qonde.

1. Session 1: Opening and Keynote Address

1.1. Welcome and Introduction

Chairperson: Mr Gwebinkundla Fellix Qonde, Director-General – DHET

Mr Qonde officially opened the Colloquium, observing all protocol and welcoming delegates to the 2019 Research Colloquium on *The Fourth Industrial Revolution: Implications for Post-School Education and Training (PSET)*. He shared some insights on the 4IR and noted that it was most fitting to be hosting an event focusing on 4IR given the recent union between the DHET with that of the Department of Science and Innovation (DSI) where 4IR has become a critical component to the work of the Department and one that is radically changing the education and training landscape in the country.

Mr Qonde highlighted that from the two-day engagement, he anticipated robust and engaging discussions that would yield positive solutions to address the diverse problems being faced by the DHET around Science, Education and Technology; and that discussions would engage on disruptions that the 4IR will bring.

Speaking about the PSET system, he pointed out that, there is a need for innovative strides to keep up with technology through skilling and reskilling citizens to enable them to adapt and flourish in the midst of technological advancements. He highlighted that it is only through strong evidence-based research that the sector could have the necessary information required to adequately prepare citizens for the future. He challenged delegates to review the current situation around gaps that exist in the PSET system and interrogate best industry practices to address the shortcomings of the system whilst having sight of where they are headed and where they will be in the future.

He then provided the outline of the Colloquium programme and encouraged delegates to deliberate on the issues impacting the PSET sector and come up with solutions that will help in developing better programmes needed to improve the system; and in turn meet the needs of students to ensure that students come out of the system better than they entered into it.

1.2. Keynote Address

Presenter: Prof Tshilidzi Marwala, Vice Chancellor and Principal – University of Johannesburg (UJ); and Chairperson of the 4IR Presidential Task Team

Prof Marwala noted that although it was difficult to define, 4IR has very real implications for all spheres of society. His address focused on 4IR and its implications for education, training and skilling. He said that in order to understand the 4IR, it is important to understand the various forms of revolution that have taken place over the years:

The First Industrial Revolution – Knowledge formulation: The First Industrial Revolution took place in England and happened as a result of the Scientific Revolution, which spawned discoveries such as Newton's laws of motion and laws of gravitation. Out of the First Industrial Revolution it was possible to understand the motion of objects and where planets would be in the next year or the next 75 years, such as Halley's Comet which is seen every 75 years and can be precisely predicted using this new understanding of how planets move.

Prof Marwala explained that the British were first to industrialise and began building machines that could be used in the production of goods, thus replacing human beings in the world of work.

As with any revolution, this revolution had its adversaries. A group of British textile workers, the Luddites, vandalised and destroyed factories and machinery used in production. However, the First Industrial Revolution continued unhindered.

The Second Industrial Revolution – Knowledge Evolution: The Second Industrial Revolution happened in the United States of America (USA) and built upon ideas that came from England, for example, electromagnetic theory developed by James Clark Maxwell. According to Prof Marwala, despite fierce opposition from a group named the Practical Men, who criticised the theoretical outlook on life, the Second Industrial Revolution marched on.

The Third and Fourth Industrial Revolutions: Knowledge Distribution and Mutation: The Third Industrial Revolution happened in Silicon Valley with the ability to transmit information at high speed. It centred on making machines or technology more intelligent.

Digital technologies driving 4IR include blockchain. There are many types of Artificial Intelligence (AI); these include:

- Machine learning – utilising statistics and data to build intelligent machines.
- Soft computing – building artificially intelligent machines with limited data.
- Computational intelligence – designing intelligent machines without any data.

Prof Marwala offered examples of how scientists and engineers observe how intelligence in nature manifests itself, such as how ants form a straight line finding the shortest distance from their nest to food source. From this, scientists developed an AI algorithm called ant colony optimisation (ACO), which is used in electronics maps to find shortest distances between two points.

Prof Marwala highlighted the following consequences that may stem from 4IR:

- Post-work era due to advanced means of production.
- Irrelevance in the 4IR versus exploitation of the First Industrial Revolution.
- Increased inequality.
- Bounded freedom as a result of constant surveillance and personal data collection, i.e. Big Brother is watching.
- Bounded decision making by humans.
- Bounded nationalism.
- Democracy in peril evidenced by the use of electronic tools and personal data to influence the outcome of elections.
- Laws and ethics to regulate automation.
- New economic theories.
- Human-robot interaction will create new psychology in people.

Prof Marwala continued that AI is changing the world of finance. In the past, accounting students at tertiary level were taught about the balance sheet, profit and loss statements, income statements and cash flow statements. Prof Marwala stated that with 4IR, all these tasks can be automated by machines. He added that even AI can assess customers' creditworthiness better than human beings.

He noted that economics students previously learned about the demand and supply curve, which is the basis of pricing. In retail, price is ultimately derived from the aggregate demand-aggregate supply curve. As a result of 4IR, online retailers such as Amazon can ascertain individuals' unique demand curve such that the price of a single good in a market fluctuates. With AI's ability to individualise pricing comes the ability to individualise production.

Prof Marwala told delegates about how academics had endeavoured to train an AI algorithm to predict whether two countries are likely to go war, using variables such as democracy, capability and dependency. Political science students were taught to make these predictions in universities; predictions which machines can do better than human beings.

Prof Marwala stated that political scientists of the future would have to understand AI. He also pointed out that the current trade war between the USA and China is in fact psychological warfare, and thus political scientists need an understanding of psychology to handle the complexity of the world in the 4IR.

Despite the introduction of new processes, such as using an accelerometer and an AI machine to measure the structural integrity of bridges, engineering skills and an understanding of Navier-Stokes equation are still critical. Prof Marwala argued that social skills now are even more important in the engineering field, which places demands on the curriculum to include elements of psychology. Furthermore, the ability to analyse data must not be restricted to students of computer science, statistics and electrical engineering. The curriculum must be expanded to ensure that engineers are well trained in social sciences and humanities.

With the use of AI in medicine, in applications like pulmonary embolism, medical scientists need to understand technology, which Prof Marwala conceded is something that is not reflected in the current curriculum. He noted that 4IR has implications on ethics. Lawyers have to consider liability in motor vehicle accidents involving self-driving cars, and issues around data privacy.

Prof Marwala was of the view that science and technology innovation is critical in the 4IR economy.

Speaking on the impact of 4IR on education, Prof Marwala said that new technologies are changing education and teaching methods. 4IR also has the following implications for curriculum:

- *4IR skills set* – Prof Marwala suggested that the jobs that will survive in the 4IR environment are those jobs that require a ‘human touch’ and human sciences would become increasingly significant. The World Economic Forum (WEF) predicted that the following skills would be needed in the 4IR:
 - Cognitive abilities.
 - Systems skills.
 - Complex problem-solving skills; content skills; process skills; social skills; resource management skills.
 - Technical skills and physical skills.

He compared this with the top 10 skills needed in 2015 according to the WEF, which were: complex problem solving, coordinating with others, people management, critical thinking, negotiation, quality control, service orientation, judgment and decision making, active listening, and creativity.

- *Techno-social scientists* – There is a need to create a new form of qualification that will contain elements of engineering, accounting, economics and social sciences so that this new breed of professionals are equipped to operationalise 4IR.
- *Early Childhood Development (ECD)* – Introducing complex subjects around the 4IR from pre-school level. UJ has published a book which introduces children to 4IR concepts, such as AI, logically and systematically.

In closing Prof Marwala told delegates that he hoped that his presentation had brought clarity on 4IR and that consideration would be given to how to ensure the education and training system should equip South Africans to take advantage of the opportunities presented by the 4IR.

1.3. Opening Remarks

Presenter: Dr Daniel Adams: A/DDG: Research Development Support – DSI

In his opening remarks, Dr Adams presented on the implications of the 4IR on PSET. He discussed:

- The state of readiness.
- Related governance structures that are required.
- The role of government.

He explained that the 4IR is a technological development that fuses the physical, the digital as well as biological domains and integrates AI. He commended DHET, noting that the world and the country would be better prepared for this revolution, unlike the past revolutions where various mistakes were made that resulted in massive exclusion and human rights violations, deepening inequalities, poverty, hunger, mental damage and regulatory lag.

Dr Adams emphasised that embracing 4IR should not be mistaken for being leaders in technology development, but for being leaders in technology governance in order to create an environment that allows technology to evolve and emerge safely and organically. He remarked that the South African government needs to look at the needs of the citizens and ask itself what efficiency solutions could be brought by this revolution to improve the country and livelihoods. The government must therefore develop a framework for the use of AI in the economy and other sectors. This will address ethical issues that might come up later. Countries such as Germany and France already have national AI strategies.

Government has to play a leading role in:

- Data collection, management and its availability.
- Developing coordination structures, mechanisms, frameworks, guidelines and principles across all sectors to ensure effectiveness.
- Development of national policies on big data, open data, open science and innovation including data ethics, data privacy, data protection and good practices, and standards.
- Providing necessary incentives for data sharing for the development of policies.
- Affordable broadband connectivity for all, because that will be critical to move data around and really exploit the value of big data.

Discussing the potential implications of the 4IR on PSET, Dr Adams highlighted:

- The accreditation procedures would have to change. The accreditation system of the universities needs to be in line with the fast innovation cycles.
- New roles for examination officers.
- Flexible degrees on training programmes offered in partnership with industry.
- Introduction of nano degrees where people are trained for a single or particular skill compared to the more general degrees.

Dr Adams also argued that the 4IR removes boundaries and borders. This means that teaching and learning has to adapt to the needs and demands of a 4IR citizen. New teaching methods will also have to be adopted. Educators will have to teach new concepts, use new teaching infrastructure equipped with virtual worlds to meet the flexible demands created by the revolution. Online delivery of learning material will become necessary. This will impact the future models of higher education and training institutions. Virtual classrooms, not just locally but also globally, given the collectiveness of the 4IR will become the norm.

Learning will be characterised by:

- Increased computing capacities.

- Shift from the present learning to increased distance learning.
- Seamless integration of all types of information across different platforms.
- Individualisation – self-based learning versus module individual degrees.

To respond to the demands of the 4IR the curriculum must be relevant, must be a combination of fundamental as well as industry-focused content including entrepreneurship, innovation skills, values, ethics, and even morality, infused with market-related skills and competencies.

Dr Adams stressed that the 4IR was characterised by algorithms and big data. Data engineering will become a critical skill. South Africa only produced 16 post-doctoral graduates in statistics in 2015. The overall proportion of female and black graduates remains small. Given the trends in foreign student enrolments, the portion of South African doctoral graduates on the same subject is actually declining. PSET has to respond by developing a curriculum that adapts to the growing demands and future needs of the workplace.

The DSI, together with other departments, has introduced various interventions aimed at ensuring teacher readiness as well as creating an enabling environment. Some of the initiatives include:

- A White Paper on Science and Innovation, and a national e-science postgraduate teaching and training programmes' platform, which is a consortium arranged between six universities with a focus on the delivery of a structured multidisciplinary Master's course in Science.
- The Department of Basic Education (DBE) is piloting the coding curriculum and robotics in the school curriculum.
- An Inter-Ministerial Task Team has been set up to investigate the implication of the 4IR on PSET and recommend possible responses by the state.
- An enabling environment has been created. Institutions of higher learning have been equipped with an Information and Communications Technology (ICT) infrastructure and high-speed connectivity.

1.4. Discussion

Question	Answer
<p>Q1: DHET: What are the effects of corruption and other current challenges on all of this?</p>	<p>A1: Prof Marwala: The issue of corruption has to be dealt with. In rural South Africa, there is little connectivity. Data cannot be downloaded, which makes teaching methods like the 'flipped classroom' (where students are expected to know the content before the class begins), impossible. There was a "1% of revenue" tax on commercial companies to set up a universal services agency; very little was achieved by that. There is money but it is being used for the wrong things.</p>
<p>Q2: University of Zululand (UniZulu): To what extent are the views of students and learners being included in policy formulation?</p>	<p>A2: Dr Adams: There is a move around citizen science asking how to stimulate society to participate in science. This is a new area of knowledge and the question is how do we document it? This is where we use the students – to collect data and to explore. For example, a student discovered a new star; that happened because he could participate.</p>

<p>Q3: Umalusi: What can we learn from the past in terms of 4IR? Is there room for indigenous learning in all of this?</p>	<p>A3: Prof Marwala: It's important to know what happened in the past because otherwise you will not understand the present or predict the future. That's why there is a call for multi-disciplinary education. You cannot escape technology, but you must acknowledge social and human studies too. If you do that you will have to study the learnings of the past, including Africanism.</p>
<p>Q4: Banking Sector Education and Training Authority (BANKSETA): In a South Africa that is predominantly rural, where infrastructure and connectivity are challenges, is 4IR urban-biased?</p>	<p>A4: Mr Qonde: We are talking about infrastructure and the provision of infrastructure is equitable allocated by the fiscus. It doesn't always get there.</p> <p>A4: Dr Adams: Almost everyone has two cellphones. How can we exploit that power of mobile capability, especially in the rural areas to drive mass rollout of connectivity via the universities and other institutions is required?</p>
<p>Q5: Energy and Water Sector Education and Training Authority (EWSETA): The task of 4IR rollout is mammoth especially around infrastructure and policy needs to be formulated to deal with it. To what extent are we willing to be disruptive so the response can be quicker?</p>	<p>A5: Prof Marwala: We have to invest in making data available. It is expensive to do, so it cannot be free. Making it free will result in data that doesn't do what it is supposed to do. Those who can afford it must pay and we need to find ways of helping those who cannot.</p> <p>A5: Dr Adams: The key lies in partnerships with industry. The universities do that with IBM for example. There's a small company in Cape Town that works with the taxi industry, providing support to the associations, that's a good example.</p>
<p>Q6: PSET needs to look at new skills and reskilling, and virtual classrooms are now a feature. But what about the costs. And what about teaching students' language that will allow them to address problems on their own in the future?</p>	<p>A6: Prof Marwala: We must teach in a different way and use new technology. Virtual classrooms can provide teaching skills to areas where they don't physically exist. To make that work multi-disciplinary education is needed.</p>
<p>Q7: Limpopo Community Education and Training (CET): Have we lost the link between technology and emotional intelligence?</p>	<p>A7: Prof Marwala: Emotion is bad for some decisions. In medicine, for example, you have to be clinical. The point of AI is to remove emotions and reduce errors. But there are situations where you need human interaction, empathy, kindness etc. Both are needed.</p>
<p>Q8: UniZulu: Can 4IR be Africanised – African solutions for African problems?</p>	<p>A8: Prof Marwala: I don't like the word Africanised. It is too politically charged. Education must serve the basic needs of society; it must solve the problems that are around you. At UJ. There is a programme called Africa by Bus. Students visit other countries, identify problems and come up with solutions.</p>

2. Session 2: Understanding the 4IR in the Context of PSET (Panel Discussion)

Chairperson: Dr Diane Parker, DDG: University Education – DHET

Session 2 was a panel discussion facilitated by Dr Diane Parker, DDG of University Education at the DHET. Panellists were given the opportunity to give short presentations on their view of how to better understand the 4IR in the context of PSET.

2.1. How are Universities Responding to 4IR?

Presenter: Prof Zebon Vilakazi, Deputy Vice-Chancellor: Research and Postgraduate Affairs – University of Witwatersrand (Wits); and DHET 4IR Ministerial Task Team Member

Prof Vilakazi critiqued the concept of the 4IR and raised a number of issues on what constitutes a revolution. He argued that a revolution is tumultuous, consisting of transformative events that attempt to change the world. Revolutions include the reformation, which split the Catholic Church, and scientific revolution spearheaded by Galileo, which recognised that the earth was not the centre of the Universe.

He highlighted that every revolution is built on a theoretical framework and argued that what they are going through is not a revolution, but a series of disruptions. Referring to Moore's law, he argued that they have increased the power of computing exponentially; cell phone technology has also evolved, and internet usage has mushroomed. This is no revolution; it is a series of disruptions.

Extreme poverty has decreased as a result of access to data. The myriad of changes that are taking place is creating gender and racial imbalances, because these activities are taking place in the global north. In order to adapt to this ever-changing environment, they need to excel in areas such as big data, robotics, Virtual Reality (VR), digital government, e-commerce, and e-education.

He highlighted a number of changes across sectors including *e-Education*, noting that universities are responding to disruption in education by launching online education and massive open line systems. Wits, for example, has joined Massachusetts Institute of Technology (MIT) and Harvard on the Mook RX project.

Education has changed radically. Learning centres are becoming more interactive, including the lecture theatre. He noted that with some of these changes, a new form of computing is coming, the quantum computer which is going to change radically what universities do.

Prof Vilakazi emphasised that this change, however, is incremental and should by no means be referred to as a revolution. These are changes brought on by big data, Mo's law, AI and now quantum computing.

He highlighted that to play a role in the transformation of global knowledge, they need to produce enough knowledge to shape their history and to shape their world. Unfortunately, they are not doing this, but rather they are stewards rather than creators.

In closing he said a famous politician said, "Whoever leads AI will rule the world." He noted that they have seen the consequences of being left behind technologically and unless they progress exponentially, they run the risk of being left behind; this is something that Stanley Crubick predicted in 1968.

2.2.4IR – Opportunities and Implications for PSET

Presenter: Dr Colin Thakur, Director and Head: e-Skill CoLab – Durban University of Technology (DUT); and DHET 4IR Ministerial Task Team Member

Dr Thakur emphasised the fast pace of technological advancements compared to human development and acquisition of knowledge. He noted that humans learn progressively and yet technology was progressing exponentially – and therein lies the challenge. The skills have not kept up with on-demand needs of the 4IR.

Speaking about whether the 4IR was good or bad, Dr Thakur noted that within this context it is important to understand the number of jobs that are being lost and the jobs that are being created. In the month of June alone this year, South Africa announced 827 jobs losses at ABSA, 1 200 retrenchments at Standard Bank, 1 500 at Nedbank and 2 194 at Multichoice.

He noted that the problem with white collar job extinction is that it reduces the tax base. It also reduces downstream employment and impacts the economy; and within that context, there would be psychological and physiological impacts on people that have lost their work.

Dr Thakur commented that while there were many jobs that were being lost, there are also vacancies for other jobs. These include data scientists, with about 8 000 jobs available, 3 000 AI jobs, 2 000 computer programming jobs, 5 000 cloud computing jobs and about 1 600 Internet of Things (IoT) jobs. He argued that there will be shrinkages and job losses, then changes in the type of jobs that are available followed by new types of jobs.

The impending loss of jobs and new jobs that are required in a 4IR economy therefore place training and retraining at the core of this revolution. He said that they can use 4IR recursively. They can start using AI, VR, simulation and modelling to train underemployed people in ways that could not be done before.

Dr Thakur suggested:

- Using 4IR for skilling for the forgotten millennials at Technical and Vocational Education and Training (TVET) Colleges and CET Colleges, e.g. jobs using gamifications, AR, VR and simulations.
- Using blended learning supported by technology.

He noted that PSET therefore needs stay ahead of the curve by offering flexible training courses that respond to the demands of market. Retraining packages should be offered continuously to ensure seamless transition and capabilities of functioning in the next technological waves.

He said that it is important to note that, so far, close to 10 000 jobs have been lost in the financial sector in the past years. South Africa as a country was also facing unprecedented challenges of unqualified audits in municipalities and state-owned entities, and yet there are people in the financial sector that have been retrenched or are unemployed. As a country they need to start looking at areas of excess and surplus, and areas of deficits, and start repurposing, repositioning and re-skilling people. PSET has an obligation to do that.

Speaking about the 4IR impact and opportunities, Dr Thakur emphasised that these new technologies are having unintended consequences, thereby creating opportunities for new types of jobs. New policies, processes and laws are needed. The world of work from a standard office-based job is also changing. The gig economy is growing exponentially. People now don't need a single employer but work from wherever they are as long as they have a laptop and internet connection.

Dr Thakur recommended that to mitigate changes in jobs through Sector Education and Training Authority (SETA) sector skills planning and reporting, they must use reskilling for employed folk to

mitigate job extinction. This involves retraining and keeping workers in the same roles, rather than fundamentally changing their jobs. In the next three years, an estimated 120 million workers in the world's 12 largest economies will need to be retrained or reskilled.

He concluded that while PSET has to be a pioneer in ensuring that citizens are ready for the 4IR through responsive curricula, individuals need to understand that the 4IR demands citizens to remain teachable as students throughout their lives, and continuously re-skill and retrain.

2.3. When the Only Constant is Change: Technical and Vocational Education and Training (TVET) Responding to Changing Workplaces

Presenter: Prof Stephanie Allais, South African Research Chairs Initiative (SARCHI) PSET Chair: Skills Development – Wits

Prof Allais gave an overview of the Centre for Researching Education and Labour (REAL) at Wits, which she explained has a range of different projects that examine the complicated interfaces between education and work. She shared some critical insights on the notion of the 4IR, particularly in relation to TVET; sharing findings on employer perspectives on TVET programmes and whether these programmes meet their skills requirements in a context of changing technology.

Quoting John Dewy (1899), Prof Allais noted that 4IR had accelerated science-based interventions, vast manufacturing, cheap and fast communication, but argued that it is inconceivable that the 4IR will affect education more than in a formal and superficial fashion. She further argued the notions of workplace relevance, learning to learn and critical thinking were not new to educationalists. She urged policy makers to engage in critical dialogue with researchers, rather than to get swept away in the hype around the 4IR. Prof Allais suggested critical literature and directed delegates to information sources, encouraging them to engage in more critical reflection on the notion of technological change and its impact on education and work.

Prof Allais noted that 4IR is often presented in neutral terms, as an inevitable technological trajectory. She reminded delegates that all technology is the product of and reflects social relations, and similarly, technical and vocational education is never simply a technical issue but is unavoidably intertwined with the politics of power.

She argued that high profile reports make eye-catching headlines but make for poor policy formulation. Cautioning against paying an inordinate amount of time to futurologists, she recalled how five years ago policy makers emphasised the knowledge economy, which was thought to have the potential to change everything in education. She argued that the 4IR exists as an ideological construct, which has material consequences for the labour market and the demands placed on education, and specifically on vocational education. As an ideological construct, the idea of the 4IR encompasses far more than a narrow technical focus on advanced manufacturing.

She noted that high profile reports make eye catching headlines but make for poor policy formulation. At the moment, there are contradictory reviews on 4IR, where some research shows that 4IR will result in job losses while some research points to job gain. One of the contestations is whether mid-level skills will be hollowed out. Prof Allais referred to research that showed that mid-level skills were hollowed out before the 4IR, as well as contradictory evidence that suggests these skills will make a comeback in 4IR. There is also contestation on what the 4IR means for education. Some researchers are of the view that digital skills change so fast, and people would tend to learn them anyway, what is needed now are general skills such as literacy and numeracy skills.

Sharing on skills needs findings from two studies, Prof Allais, shared that REAL is focused on the manufacturing sector, which is experiencing technological changes. She shared results from two case studies in the Manufacturing Circle, where companies and TVET providers were interviewed to

understand the role of TVET in meeting manufacturing companies' needs. These were some findings from the case studies:

- Employers indicate a need for higher levels of Science, Technology, Engineering and Mathematics (STEM), in schooling and TVET.
- Manufacturing, Engineering and Related Services Sector Education and Training Authority (MERSETA) also indicated usual problems with TVET graduates, which included a lack of practical exposure and up-to-date theoretical knowledge for both learners and lecturers, low work-readiness, skills gaps such as critical thinking and problem solving, leadership, resilience, agility and adaptability, communication, interaction with Information and ICT and creativity.
- There are supply side challenges post higher education. The Chemical Industries Education and Training Authority (CHIETA) identified the gap between graduation and professional registration in various fields, such as engineers, as a significant supply-side constraint.
- Companies are undertaking extensive in-house training and trust their own trainers more than TVET Colleges. Companies said they work with providers, and in some cases buy them equipment, but expressed frustration in their attempts to work with TVET Colleges.
- TVET Colleges felt that they are stuck between government requirements and systems, and company expectations.
- With respect to programmes, companies expressed a strong preference for learnerships and apprenticeships rather than TVET pre-employment programmes, which Prof Allais found concerning.

Prof Allais noted that this project is currently under way and explores the contribution of TVET programmes to industrial transformation and growth in six countries – Bangladesh, Colombia, Ethiopia, Lau, South Africa and Vietnam. The object of the study is to deepen the understanding of the linkage between vocational skills development and industrial growth or transformation, especially with regard to rethinking industrial policy and sustainable development.

In the second case study, country teams conducted overviews on the skills systems and economies in relation to the manufacturing sector in the six countries. In South Africa, REAL is looking at three sectors – automotive, clothing and textile, and food and beverage. Prof Allais shared the following insights:

- Companies in all three sectors mainly reported that there has been innovation and technological change, with the automotive industry reporting the most change.
- Predictably, skills shortages exist at the lower and technician levels. However, skills shortages are most pronounced in companies experiencing the most technological changes.
- Companies were asked about their perceptions of the usefulness of TVET programmes. The study revealed that at an operator level, almost without exception, companies valued general education matric more than TVET – although there was some positive feedback around the new operator qualification.
- Companies with the most technological change were more positive about TVET qualifications, mainly due to shortages of technicians. This is something that Prof Allais said was important for policy makers to take note of.
- Formal qualifications do not adjust quickly enough, and this raises questions about the balance between formal pre-employment training and how in-company training can be supported through funding and policy regulations.

Prof Allais recommended that core parts of qualifications be retained, which will enable customisation by employers for at least 30% of a qualification. Improvements should be made to the system to ensure it adequately encourages and supports workplace-based training, which is critical to enabling workers to adapt to changing roles and to preserving new jobs.

In closing, Prof Allais said, human decisions will determine the future of work and the future of education, rather than the narrow view that the effects of technology on training and employment is predestined.

2.4. Discussion

<p>Q1: Prof Allais, please elaborate on the issue that companies have more trust in their own in-house training than the TVET Colleges?</p>	<p>A1: Prof Allais: This was based on a survey. Employers say they don't get enough direct engagement with the colleges in terms of producing what they feel is relevant. This is in some senses an unfixable problem. Education can never produce someone who is 100% work ready. You have to have work experience as well. So, it's about finding the right balance. Some of the companies say they don't trust the training from TVET Colleges and that's why they prefer to rather train their own workers instead. One, for example, said they hire operators only if they have an N6 – i.e. they have Maths and Science. They are looking for workers with core educational knowledge that they then train them.</p> <p>Another issue which came up was about the regulatory environment. It's sometimes too difficult for colleges and industry to really work together in dynamic and flexible ways. I'm not saying that knowledge is not important or embedded in technology. I'm just cautioning that we should not get too caught up in questions of whether it's the knowledge economy or 4IR.</p>
<p>Q2: CoLab Project Implementation: We speak about platforms like an online university versus unit standards and the notion of the gig economy moves away from education into specific competencies. Are we creating platforms and spaces that allow people to pick up a competency and go to the market, the gig economy, and transact without getting a whole qualification? How are we changing the landscape for young people to access competencies so they can go and be relevant in the marketplace today?</p>	<p>A2: Dr Thakur: I want to pick up on the 'the gig economy'. One speaker spoke about competencies and one of the presenters spoke about the notion of lifelong learning. I think the youth of today are also interested in just-in-time learning. They want to learn the minimum amount that is necessary to gain a particular competency in order to start doing the work that they do and that again speaks back to the notion of the gig economy. I think that we must use 4IR, for the want of a better word, for technologies like VR, like gamification to teach the youth of today new skills that they can use and become self-employed.</p>
<p>Q3: MERSETA: I want to bring together two thoughts. One from Dr Adams in the previous session who said being a leader in 4IR is not about having the leading technologies, it's about governance. Now Dr Thakur talks about the gig economy. These two issues for me are central. At MERSETA we are developing an apprenticeship online digital platform and one</p>	<p>A3: Prof Vilakazi: What we name it isn't important. So, some bureaucrats in Zurich spoke to a few consultants at MIT and they gave it a name – the 4IR. How do you leapfrog knowledge? You can do that through lifelong learning. You're going to keep on learning, and you've got various instruments that can help you. A colleague spoke about the skills that you</p>

<p>of the key challenges that we have is how to integrate the Work-Based Learning (WBL) program agreement provisions and the legislation, into a digital platform. I would like this topic to be taken up in the Presidential commission. How are we going to marry legislation and the current limitations in legislation to digital teaching and learning?</p>	<p>need. There is actually a computer that can program itself through the IoT so even the actual coders might be extinct in the next 20 years. New jobs are going to be created that will require a multiplicity of skills. The answers to the questions of lifelong learning and adaptability are well covered.</p> <p>AI is a buzz word, it's nothing new. In a 1968 film "2001: A Space Odyssey" it was predicted. It's been brought to the fore now because of advances in big data and because computers are much faster. Let's not get caught in these terms. We just have to move with this exponential dimension and be adaptable as we go along without being caught in endless debates.</p>
<p>Comments</p>	
<p>C1: Cape Peninsula University of Technology (CPUT): The knowledge economy is still very much where we are at the moment. My understanding is that technology is defined as the knowledge residing in the artefacts, the people's brains, the machines, etc. 4IR, in terms of automation, digitisation is really about data, information and knowledge. So, it's not a new trend, we're just basically taking charge of what there is and bringing that back together in a bigger picture.</p>	
<p>C2: University of South Africa (UNISA): In Europe, schools are closing because of too few children. Africa is a young continent, there are too many children. If we are to take this 4IR seriously and change our education system, we need African leaders to acknowledge it. Many haven't even heard of it. There is a handful of people that really understand 4IR and how it relates to TVET. I think we must run with this. It doesn't wait for anybody. It's going to leave us behind as a country and as a continent.</p>	

3. Session 3: Continental Perspective

Chairperson: Mr Ghaleeb Jeppie, Chief Director: International Relations – DHET

Mr Jeppie highlighted that the premier agencies in the continent, the African Union (AU) and Southern African Development Community (SADC) were developing strategies and plans to engage the 4IR.

He challenged delegates to consider that by 2050, Africa's population would be 2.5 billion people. As such:

- What is the curriculum of the future going to look like?
- How is it going to support the young generation coming forward?

He emphasised that they were already in the middle of the 4IR. The revolution was evolving fast and was unequal.

3.1. Sustainable Development in Africa through the 4IR

Presenter: Dr Geci-Karuri-Sebina, Visiting Fellow: Wits School of Governance and DHET 4IR Ministerial Task Team member

In her presentation Dr Karuri-Sebina highlighted that the 4IR is not a new concept, as people are already using various technologies and creating more uses for the technology in the process. She was, however, concerned about the disconnect between the solutions that technological hubs are creating

and the needs of the broader society. She argued that although these technologies are ground-breaking, they are not efficient, as they are not solving people's problems and are therefore not fit for purpose.

She presented research findings from '*Future of Work in Africa*', a study done for the African Development Bank (AfDB), and another study by the AfDB which focused on 4IR job creation and skills in Africa. The studies covered 11 countries. The research found that not only is Africa a youthful population, but the unemployment rates are really high. Furthermore, the continent is also ill equipped in that population group (youth) for job openings and instability is therefore a concern for most countries.

She cautioned that while there is a lot of talk about industrialisation and the prospects for job creation and what the 4IR might do to the projected numbers, the reality was that the economies of many African countries are dominated by agriculture and are predicted to continue to be largely dominated by agricultural production.

She also highlighted that:

- 80% of Africa's employment was in the informal sector.
- About 34% of eligible school age population in Africa have no access to any form of post-secondary education.
- There are high levels of inequality, with black people, girls and women the most disenfranchised.

So, what does this all mean for 4IR? She asked if Africa could afford to invest in 4IR without fixing the skills mismatch and narrowing the skills gap.

Speaking about the preparedness of the education systems for 4IR technology, Dr Karuri-Sebina reported that the studies found that preparedness was perceived to be low, and lowest in the secondary and primary sector. There was an overarching view that education systems are misaligned to the requirements of the 4IR, and this was across all of the countries. There were references made to issues such as low levels of use of ICT in education. TVET Colleges and universities were considered slightly better aligned, but not well aligned.

4IR needs to respond to the needs of the society. It must create tangible solutions for current problems. She cautioned the delegates and also emphasised the findings from the research that many African countries were investing in complex technological systems, only to find that the basic physical infrastructure, capacity and resources needed to support full operational maintenance, are actually lacking. Teachers are also failing to use and apply ICT to complement their teaching, meaning that the introduction of ICTs, in general, has not improved the outcome.

She advised that Africa and its leaders need to approach progress systematically and link to enabling infrastructure. Africa must address low levels of access to the internet, poor quality of connectivity, high cost of data and in some cases still no electricity. She maintained that it was not a question of distributing computers but of creating enabling infrastructure that will create sustainability.

Dr Karuri-Sebina informed delegates that perhaps 4IR in and of itself was not Africa's immediate challenge, while acknowledging that they are already in the era of 4IR. Up-skilling and re-skilling are more urgent issues. Efficiency of their systems to produce the actual solutions to the issues is what is needed.

She highlighted that there is a need for:

- A greater sense of urgency around the development agenda, imagination, inclusion, collaboration and smaller initiatives.

- A more distributed and innovative form of leadership that itself is seeking to enable rather than to constrain and contain.
- Greater self-reliance solutions. Their solutions must be fit for purpose and not be disconnected but connected to their reality. Entrepreneurs in the technology space need sustained support and enablement for what they are already trying to do.

In closing, Dr Karuri-Sebina challenged delegates to consider that Africa was straddling multiple industrial revolutions all at once. They therefore have new problems and new opportunities, but they also have some old ones. They need to be able to think about these as well, in order to capitalise upon the opportunities. They need to prepare **for the problems they have**, not for the problems that they don't have. They need to use socially relevant models of co-creation and shared value, being careful not to exacerbate exclusive growth.

Africa's urgency requires imagination, inclusion, collaboration, scaling, leadership, self-reliance and identity. If they get these right, they will then be prepared for whatever future they find themselves in, whether it is the 4IR or not. Sustainable development is therefore about their spaces being more liveable, enabling growth and sustainability.

3.2. Discussion

Comments
<p>C1: Council for Scientific and Industrial Research (CSIR): I'm encouraged by the results of the survey in terms of how Africa is seeing the 4IR and what the potential is. Africa is aware of the 4IR and the hype has already been created. Africa has a youth dividend; it has a huge youth population and we know that a large percentage of the youth is unemployed. This means we've got a youth population excited about the 4IR, but not necessarily enabled to participate in it. The mismatch between the number of jobs that are available in the digital space versus the number of digital skills produced in the country, is not a new thing. Ages ago, we spoke about the knowledge economy; we should be producing those skills by now. That talks to the urgency with which we need to address this situation, because the people in this room are largely responsible for enabling that youth population to participate in the 4IR and have meaningful work in the digital arena. An example that illustrates how we cannot discount the youth is the youth revolutions in the global north in the late 1960s. Disenfranchised youth fought back and, on this continent, we won revolutions in the late '70s through disenfranchised youth.</p>
<p>C2: Dr Karuri-Sebina: Regarding the CSIR's point on the importance of youth and the urgency needed, I'm absolutely keen on these two days embedding quite strongly the importance of urgency. There is a lot that is already happening, how do we enable it and how do we see it as an urgent issue?</p> <p>One of the case studies we looked at is around the health sector linked to the Ebola pandemic in the Democratic Republic Congo (DRC). The person who authored that paper makes a point about how one of the biggest failures in how we've attended to and thought about the health crises and pandemics on the continent is in understanding that there is new cutting edge technology that is important and could make a big contribution to our health systems. But there is also so much in our existing community-based systems which we have failed to leverage to achieve the simplest things. He comes up with this little model we're hoping will be useful to help people think about how we can leverage both and how not to jump into a high-tech conversation. In a constrained environment you may not solve any problem but combined with well-established indigenous capabilities that may not be fully effective on their own, it can be augmented or supplemented.</p> <p>A frequent conversation in the property sector is around how prop-tech and blockchain can change the sector. Of concern is that often the conversation is about how to use blockchain to efficiently manage property markets, the system has been broken for a long time and it's difficult to understand why there is an attempt to make the system more efficient. Blockchain also allows</p>

disruptions in how the sector works and enables the sector to completely work differently – that’s how much more responsive it is. It is still in the realm of the high tech, but much more attuned to current problems, including making the current system more effective. The approach ought to be about disrupting it so that it is a more inclusive system that does what is needed of it. The same technology might enable a different set of questions to be asked. Therefore, there is a need for stronger user orientation.

Soft skills and the human issue also need to come through more strongly and one big criticism is that these studies have been very technologically led, and these studies need to look beyond some of the technological questions to some of these other social ones.

Critical thinking and problem-solving are quite critical skills. At the time of my studying Computer Science, there was no course called critical thinking or a class that was called problem solving. The issue is that there aren’t enough conversations about the social sciences and the humanities, and how they connect; the risk is that those skills are being ignored. Or is there ignorance of parts of the education system that may not sound like skilling and training for 4IR but are absolutely fundamental to building up those kinds of skills.

C3: University of Stellenbosch: I’m really glad about the way you’re framing this debate with regard to the existing realities of social life in Africa. I get the sense that there is tension in how we are currently framing it as a high-end technological development as opposed to user technology in a broad range of platforms and livelihoods.

C4: UNISA: Critical thinking and problem solving must be included in education because with technology, everybody is leaning education towards assessment, but you need to think outside the box. In the 4IR and the future of work, you must be able to handle crisis management. One thing that will not disappear is the human factor. There are many operations being performed with AI, but the personal touch will not disappear, and it is that personal touch that we need to focus on. Those are some things that I would like you to include in your study, or possibly make it a recommendation.

4. Session 4: Implications of 4IR and Learnings (Panel Discussion)

Chairperson: Prof Aslam Fataar, Vice Dean, Research, Faculty of Education: University of Stellenbosch

Prof Fataar who chaired the session, noted that the session sought to highlight 4IR implications for:

- Structures, qualifications and curriculum design.
- Education, teaching and learning; bearing in mind that technology develops exponentially, and humans develop incrementally.

Prof Fataar emphasised that when discussing curriculum, it is important to consider developing a curriculum teaching architecture that speaks creatively to address the tension between exponential technological development, on the one hand, and on the other, incremental developments to which humans are subjected.

4.1. Implications for Qualification Design, Accreditation and Certification

Presenter: Dr Vidmantas Tutlys, Research and Lecturer: Academy of Education Science – Vytautas Magnus University, Lithuania

Dr Tutlys’ presentation was based on a research paper he co-authored with Prof Gerald Straka from Bremen University. The paper is currently in its final stages of publication. The research sought answers to:

- Whether 4IR would challenge the existence of vocational and professional qualifications in the current form leading to their fragmentation and dissipation into more flexible and easier adjustable elements?

- Whether there is a place for a qualification as they understand it now in the dynamically changing world of business and work depicted in the visions of 4IR?
- Possible implications of 4IR for the processes of design of qualifications, their accreditation and certification?

Dr Tutlys noted that the 4IR is increasingly being characterised by autonomous self-control of the production processes executed by smart production technologies. These reduce the importance and demand of competencies and qualifications in the work, organisation and execution, together with the elimination of humans from some work processes. The following implications of changes for competencies and qualifications were identified:

- There is a shift from qualifications to competence in processes and practices of human resource management and development.
- Changes of the content of work processes – Increasing fragmentation of qualifications by seeking to increase the flexibility of their contents and adaptability to the requirements of fast adjustment.
- Increase personalisation and individualisation of qualifications.
- Enhance virtualisation of the design, awarding and maintenance of qualifications.
- Macrostructural changes of the work or work and labour market – hybridisation of qualifications caused by the merger of the different work processes due to technological development.
- Emergence and extinction of qualifications.
- Proliferation of corporate qualifications.

Dr Tutlys described the scenarios of the development of the 4IR (as argued by Hirsch-Kreinsen, Ittermann, 2017), as follows:

- The scenario of upgrading work qualifications suggests that 4IR will develop as a moderate technological change in industry followed by the corresponding upgrading and improvement of productivity and quality of work.
- The scenario of an automated factory stresses differentiation of the loss of routine and low-skilled jobs in the sectors of economy.
- The scenario of work polarisation looks into macro-structural development of the labour market, claiming that the development of 4IR especially the interplay between work, automatisisation, informatisation, and digital taylorism, tend to reduce the importance and need of middle level occupations and qualifications.

Dr Tutlys shared that researchers Lee and Pfeiffer 2017 stress technological and organisational change in the scenarios they identify:

- Growing gap scenario - foresees reduction of demand of skilled workers at the shop-floor level and increasing demand of skilled workforce in the planning and design of the digital control systems and their application in the production processes.
- The general upgrade scenario – Assumes incremental and progressive technological change. While networking of the production increases the volume and contents of the processed data and CPS big data provide solutions to cope with these challenges, the meaningful interpretation and evaluation of data contents is reserved to humans.
- Central link scenario - stresses implications of the technological innovations for networking of physical and virtual digital world, integration of the mechanical-electronic production processes into unified digitalised business structures and digital networking through an IoT and services.

He also shared scenarios from the Bayme Study conducted in 2017. The study discussed the anticipated changes in the structure, content and of the processes of education, training and assessment of learning. They argue that:

- The first scenario claims, that development of the 4IR does not cause significant changes in the provision of vocational education training at least in the short period of time.
- The second scenario claims, that the structure of the vocational education training provision will remain unchanged, but the contents (curricula) will have to be adjusted to the requirements posed by the 4IR.
- The third scenario expects combination of existing occupations and qualifications.
- The fourth scenario foresees development of the separate highly specialised qualifications oriented to the requirements and needs of the 4IR.

Dr Tutlys said, the scenarios of the development of 4IR foresee a role for vocational and professional qualifications, although with possible significant change of their structure, content and regimes of access to qualifications.

Qualifications in the dynamically changing world of business and work depicted in the visions of the 4IR are strongly affected by the technological work processes and their integration from the one side (solid qualifications), and requirements of flexibility and fragmentation (modularisation) to respond to the quick change from the other side.

Dr Tutlys highlighted, that the 4IR significantly challenges the roles and responsibilities of the existing stakeholders in the processes of design of qualifications, their accreditation and certification: increasing role and importance of the enterprises and providers of technologies, challenges to the traditional established responsibilities of the state and public vocational education and training providers in the design of qualifications, provision of training, assessment of competencies and awarding of qualifications.

The 4IR therefore requires a holistic and open model of competence based on the systemic understanding of the work processes and their networking interrelations, as well as capabilities, to combine real and virtual world information. Skills and competencies of process engineering become increasingly relevant and important for the execution of skilled work in the production, exemplified by the paradigm of augmented operator enabled to interact with intangible assets and digital contents.

Dr Tutlys highlighted that the changes in curriculum design and architecture also have implications for the awarding of qualifications, and accreditation of awarding bodies. He made the following recommendations for consideration:

- Usage of blockchain technologies in the assessment and recognition of competences and awarding of qualifications: De-institutionalisation and fragmentation of awarding qualifications, individualisation of information and data treatment in this field.
- Increasing role of the providers of 4IR technological solutions in the provision of initial and continuing vocational training, including virtual work-based training, would increase their role in awarding and ownership of qualifications.
- Spread of the informal qualifications recognised at the level of enterprise, informal training provider or other informal agents.

In closing, Dr Tutlys recommended:

- That training modules should be based on the concrete production projects in the fields.
- A combination of classroom learning, WBL and e-learning.

- Promotion of collective learning and development of competencies of cooperation and team working in the production processes. The learning product is achieved through cooperative and interdisciplinary work.

4.2. Implications of 4IR for Curriculum Transformation

Presenter: Prof Sarah Gravett, Executive Dean, Faculty of Education – UJ

Prof Gravett's presentation focused on curriculum transformation, specifically, programmes in post-school education. She made a case for rethinking post-school curricula, guided by the question, "What should students learn to best prepare them for the present, the fast-changing world and unpredictable future?"

In this context she highlighted the importance of personal knowledge and noted that there is a need to distinguish between information and knowledge, as thinking depends on personal knowledge, stored in one's memory. Critical thinking, which entails assessing evidence and considering alternatives, requires one to draw on one's knowledge base.

Prof Gravett argued that thinking creatively and innovatively is often the result of grappling with incongruities in one's knowledge or connecting seemingly unrelated aspects. For example, one can Google some facts and detail, but knowing what to Google depends on what one knows.

Prof Gravett emphasised the importance of the "four Cs" in learning, critical thinking, creative thinking, communication, and collaboration, especially in the 21st century skills, but these are not new. She highlighted that cultivating "the four Cs" in post-school education will help prepare students for the complexity of a fast-changing world.

Prof Gravett posed the question whether it makes sense for students to learn or memorise large amounts of detail when they can find information on the internet? Her argument was that domain-specific knowledge and specialised skills remain important, especially within the context of the question posed; and higher education should begin to produce "T shaped" individuals with thorough knowledge and skills in one area, and the ability to work beyond their area of expertise to collaborate in other fields or disciplines. Prof Gravett argued that working beyond one's area of expertise or collaborating in other fields requires the four Cs.

Prof Gravett recommended that the higher education curricula should make learning central, not content; and move away from the notion of curriculum coverage.

Prof Gravett said some of the questions to ask in order to curate purposeful and meaningful curricula include the following:

- Is quality or rigour equated with quantity so that curricula are overloaded?
- What are the essential elements of the given field of study or discipline that students should learn?
- What are the key concepts, processes, methods, tools and skills that are likely to matter in the work lives that students are likely to live?
- How often will the concepts, processes, methods, tools, and skills that are viewed as key, serve to inform decision making in action in the lives that students are likely to live.

She noted that the type of learning that enables transfer should focus on understanding and knowledge for expertise and transfer and must enable individuals to think with knowledge, and to use prior learning to support new learning or use prior learning for application and problem-solving in relevant contexts.

She highlighted that deep or deeper or meaningful learning should be fostered, as it is not a product but the process through which transferable knowledge develops.

Quoting James Garabrino, Prof Gravett said, "Through deeper learning, individuals not only develop expertise in a particular discipline, but they also understand when, how and why to apply what they know, and very importantly, they recognise when new problems or situations are related to what they have previously learned and they can apply their knowledge and skills to solve them."

This means that transfer does not happen automatically. A lack of practice in applying concepts to different situations and contexts, or not making interdisciplinary conceptual links where relevant, inhibits transfer. In addition, assessment that requires recall of discreet information or skill rather than knowledge application in various contexts may inhibit transfer. Teaching that focuses on intentionally, systematically and demonstrably enabling deep learning fosters transfer.

Prof Gravett noted that while teaching for deep learning may be deemed as time-consuming, it cannot be done in a crowded curriculum; as curriculum suffers from a crowded garage effect; and such coverage does not enable learning for transfer.

Prof Gravett raised the following issues:

- Getting rid of the crowded garage effect in a curriculum requires a willingness to prune the curriculum to make space for deep learning and for infusing crucial 21st century literacies such as information and data literacy.
- Experts are often unwilling to let go, they feel responsible for upholding earlier standards and promoting their benefits.
- Experts find it difficult to discard parts of the whole cloth of their field's knowledge, even after those parts have become outdated or less useful.

Prof Gravett highlighted that curriculum transformation will require assessment transformation, noting that assessment practices signal what is truly valued in higher education. She quoted Derek Roundtree who said: "If we wish to discover the truth about an educational system, we must look into its assessment procedures. What student qualities and achievements are actively valued and rewarded by the system? How are its purposes and intentions realised? To what extent are the hopes, ideals, claims, and objectives professed by the system, is it truly perceived, valued and striven for by those who make their way within it? The answers to such questions are to be found in what the system requires students to do in order to survive and prosper. The spirit and style of student assessment defines the de facto curriculum".

She then recommended that assessment for deep learning should focus on:

- Defining precisely what knowledge students are supposed to have learned, and the ways in which they are supposed to know and understand this knowledge.
- Specifying explicitly the evidence that will be accepted that the student has learned the desired knowledge.
- Designing or selecting assessment tasks based on the first two components of the design process.

Prof Gravett concluded by saying fostering deep learning requires working deeply, with essential elements of a given field of study, those elements which are likely to matter in the lives that students are expected to live personally and in their work lives. She cautioned that this cannot be done in a crowded curriculum. She also cautioned that quantity should not be equated with quality. Well-considered and carefully selecting less in the curriculum is more beneficial for now and for the future.

4.3. Implications of 4IR for Pedagogy

Presenter: Prof Wendy Kilfoil, Consultant: Department for Education Innovation – University of Pretoria (UP)

In her presentation Prof Kilfoil noted that in Europe and the United Kingdom (UK), they use the term 4.0 rather than 4IR when referring to the Fourth Industrial Revolution and there needs to be a clear understanding of what 4IR is. She explained that 4IR encompasses the use of data from multiple sources, algorithms, machine learning, learning in learner analytics, and cyber-physical systems; and one of the biggest challenges is that many do not know what to do with 4IR tools.

She said, 4IR is apparent in the workplace and higher education and noted that data and algorithm-driven online technology have been dominating their lives for over a decade. Google is a classic example of this, universities are using blackboard or publishers in e-guides, chatbot and the adobe creative cloud. The rise of the use of technology across sectors has been evident over the past few years. For example, universities are offering courses such as that offered by the Centre for the Study of AI at MIT. He added that mining engineering is using a VR tunnel; and that three Dimensional (3D) technology is also being used in the health sciences and dentistry. Furthermore, individual lecturers are using a lot of game-based learning.

Prof Kilfoil argued that while all of this is happening, they lack the architecture of the infrastructure to bring all of this together into the public domain. Teachers and lecturers need to be creative risk-takers, not transmitters of what they already know.

She noted that while university professors are working on AI for banking and other commercial products, very few are working on higher education; and this needs to change. She emphasised that it's important for students to understand 4IR while they are in learning institutions as they do not want students going into the workplace and jumping when they meet a robot for the first time.

She noted the following advantages of humans over machines:

- Robots will not replace teachers because robots cannot inspire them, according to Daphne Koller, Head of Consera.
- Machines cannot create content or design curricula.
- The concept Humanix says one needs human sciences knowledge, technical knowledge and data knowledge.

Of concern, Prof Kilfoil said is that AI may emulate the bad practice of Massive Open Online Courses (MOOCs) and not the good practice of research and distance education over the decades; and AI could become another deliverer of content.

She concluded with the following recommendations:

- Improve the digital literacy of staff and students; their ability to use digital tools to communicate, to solve problems and be creative.
- Design short courses to bring all students and staff up to speed on computational thinking.
- Encourage experimentation through a system of rewards or incentives.
- Partner with providers who are using AI.
- Collaborate to bring academics and students in on the ground floor, in the design, in the development and the piloting.
- Provide inputs into what goes into the data and algorithms to ensure completeness and adequacy.
- The universities that are researching AI in South Africa need to spend some of their time working with the academics and the students so that they get some investigation into higher and further education.

4.4. Discussion

Question	Answer
<p>Q1: JET Education Services: There are taxonomies for skills and competencies as well, and how do we engage these taxonomies to think properly about knowledge skills and competencies in this new era?</p>	<p>A1: Dr Tutlys: There are currently discussions in Europe on higher education and vocational education and training; mainly around competence and applicability of this concept, and the current context of change, including the 4IR. There is a trend towards a holistic concept of competence, which requires the application of knowledge, of practical skills, and also key skills / competencies, in the solution of different professional tasks, tasks in the work processes and other tasks and objectives in social life, citizen’s life and personal life. The holistic concept of competencies should gain increased support and usage, especially in vocational educational training.</p> <p>A1: Prof Gravett: These terms are being used interchangeably. Competencies are broader. They include skills and knowledge. Knowledge is the traditional disciplines, the modern disciplines, which is more, in a sense, interdisciplinary in nature. Skills are what you do with the knowledge. It is not possible to read, to learn skills separate from knowledge; they are intertwined.</p> <p>A1: Prof Fataar: Speaking about disciplinarily might be too limiting; it is multi-disciplinary, interdisciplinary, and trans-disciplinary. What are the knowledge constellations that are coming together? What are the parts of different disciplinaries, the disciplinary constellations that constitute what we would regard in old fashioned terms as disciplinary knowledge? Disciplinary knowledge emerges out of the interaction between technology, between innovation, between various disciplines, and part disciplines coming together. Bloom’s taxonomy is not rich enough to capture the complexity.</p> <p>A1: Prof Gravett: Taxonomies are useful, but they are not always used correctly, even Bloom’s taxonomy. If we understand what deep learning is about, we know that if one wants to gain deep learning, it is done through all these other processes of critical analysis; you cannot separate them. Taxonomies are helpful, but not to necessarily guide curriculum development.</p>

	<p>Traditional disciplines have still a very important role also to play, but we need to understand that new disciplines are being developed. We must be open to these.</p>
<p>Q2: King Hintsa TVET College: With individualisation, do you concentrate on different intelligences that are there for individuals, and, with the thought of placing learning central, does that have to do with the abilities and competencies of students?</p>	<p>A2: Prof Gravett: We want students to learn. We are not teaching to cover content. Even in higher education, content is central. People believe that when you have covered something, you have done your duty. We need to focus on what students are supposed to be learning; this does not necessarily mean individualising education. It is important to think about what we want our students to leave with, what they should have learned, not what we have covered with them. If we look at education in this way, in terms of what the market wants, we will be delivering people to the market who deeply understand their field and who can learn, are versatile and learnt during their undergraduate or post-school education, how to develop further as individuals and how to learn.</p> <p>Assessment is what we value. You will often find that there is lip-service, that this is the graduate characteristics. When you look at the assessment, you will find that assessment requires in many cases reproduction of information, even in higher education.</p>
<p>Q3: How we assess students indicates what we value. It has been easy to walk out with certification; the market knows and understand that and can buy it. Now, with this notion of deep learning, how does that correlate to what the market is going to buy?</p>	<p>A3: Dr Tutlys: We have one project that deals with mechatronics; another deals with C&C operators. In the case of C&C operator, this project developed very individualised curricula; the learning can be very individual. In the case of mechatronics and electronics, the nature of the work process and the work tasks requires a lot of team working and cooperation and increasingly this pressure on teamwork and cooperation will continue with the implementation of digitalised technologies of these CPS systems, they will require teamwork, and therefore the models that they developed in this project, are based on the collective work collective learning, and collective teamwork. In vocational training, it very much depends on the occupation, on the nature of the occupation.</p>
<p>Q4: CoLab Project Implementation: What is being done in terms of the teaching staff in delivering new concepts aligned to the new world of work which teaching staff did not cover themselves when they studied?</p>	<p>A4: Dr Tutlys: Teachers' qualifications and teachers' competencies are crucial in this regard. One solution is that teachers should spend much more time developing their professional skills in the real-world processes. It can be done by way of internships or work placements. I introduced one of these projects, vocational educational and training for working</p>

	<p>world 4.0. In the website of this project, you will find links to the training and the learning materials and these learning and training materials; they are also prepared for the teacher. We also developed competence methods for teachers, addressing the kind of competencies vocational teachers will need to have in the future of electronics and mechatronics. Modules were also developed for the teachers, to develop their skills and competencies. It is very important to involve teachers in acquiring digital skills.</p> <p>A4: Prof Gravett: What we teach and what students are supposed to learn must be relevant to the market. We must teach knowledge that will endure in the longer term, which would mean that they are ready for the market. The world is changing rapidly. It is not possible to prepare students for the world of work forever. They have to be learners while they are working. We teach them life-worthy knowledge, knowledge that has the potential to endure. Many teachers at university do not necessarily have some of the knowledge we would need, but university teachers are lifelong learners. There are also many partnerships with industry, where you invite people from industry to become part of programs and co-offer such programs at post-school institutions.</p> <p>A4: Prof Kilfoil: It is important to have different kinds of degrees, multi-disciplinary degrees. We need a different type of qualification. If you want to be integrated, you could have team teaching, so that the same course was taught by a combination of lecturers across different disciplines, to complement each other's knowledge bases and skills. We are underestimating many lecturers. We need creative risk-takers in the classroom; we need to look for this when we appoint staff.</p>
<p>Q5: DHET: Is South Africa ready for the 4IR; this is interrupting or disrupting the addressing of the previous imbalances and inequalities in South Africa?</p>	<p>A5: Prof Kilfoil: It is a mistake for the higher education sector to think they are preparing people for the world of work; this is not the function of education. We had a flexible futures conference a couple of weeks ago, and the keynote speaker was Heather McGowan from Work to Learn. She said in the past we would go to a university to learn to work. Now we need to be in the workplace in order to learn because that is where technology is being introduced, where routine jobs are being replaced, and where we</p>

can learn about the new knowledge. If our students are lifelong learners, they can always do a MOOC. There is plenty of content for people to access; we have to teach them something different in education.

A5: Dr Tutlys: The issue of outdated qualifications, or updating of qualifications, is of these painful questions caused by industry 4.0 that systems of qualifications are only capable to respond in time with all these changes. It is the same in all countries. A possible solution is to find a compromise between updating qualifications as a kind of formal descriptor of requirements of work.

What is important is the development of work process, based on work process-oriented learning, in the processes of teaching and learning, especially when we are talking about vocational educational training. It means that different kind of work-based learning approaches, apprenticeships, should be further developed and should be expanded. With the very strong involvement of learners in all the processes starting from curriculum design than, organisation and training of, this is also very important.

A5: Prof Gravett: We can lay a solid foundation in post-school education. We have always been preparing students for an unknown future. The difference now is that changes are happening much faster and technology is becoming more and more pervasive; this is the difference between preparing people for an unknown future in the past and preparing them for an unknown future currently. We do not know what that future is.

Ready or not the 4IR is happening. We must understand how our world is changing. I prefer to talk about a fast-changing world, an unpredictable world, a world where technology is becoming more and more pervasive, and that is a fact whether we want to know it or not. It would be irresponsible for us not to take account of that. We must prepare our students for what is happening now. If we only prepare students for the current situation, how are you going to have change in education? You must also give them a vision for the future. If we sit back and we say we are not ready, we will still

be the object of the 4IR. We must become the subject of the 4IR.

Comment: Our job in higher education is to prepare students of the future and students of the present for a world of work that we may or may not know, so why are we focusing on the 4IR? We are providing content and context for students to prepare them for a world of work that is not now. The student who sits in university will go into the world of work in the future. We have missed that and part of that for me is not the 4IR. The student of tomorrow does not look like us or behave like us. We need to have a conversation about what they look like and how we will teach them. Which is the content and methodology, but it is also the climate that we are going to have to deal with, and I have not seen that yet; this needs to be part of our discussion.

5. Session 5: Parallel Commissions

5.1. Breakaway Commission A: Skills Supply and Demand in the Context of the 4IR

Facilitator: Ms Mamphokhu Khuluvhe, Director: System Monitoring

Scribe: Ms Edzani Netshifhefhe, Deputy Director: System Monitoring – DHET

Ms Mamphokhu Khuluvhe facilitated the breakaway session which was aimed at unpacking the supply and demand in the context of 4IR. She said as the 4IR was already happening, and happening fast, there was a need to catch up. A starting point would be to examine the supply of skills and demand for skills to determine which occupations will be in demand and which will be obsolete in the future as a result of 4IR, as well as its impact on teaching and learning.

5.1.1. Balancing Skills Supply and Demand: A Media, Information and Communication Technologies Sector Education and Training Authority (MICT SETA) Perspective

Presenter: Mr Thabang Motsoeneng, Research: Sector Skills Plan (SSP) – MICT SETA

In his presentation Mr Motsoeneng shared insights on balancing skills supply and demand in the context of 4IR focusing on the five MICT SETA sectors. Mr Motsoeneng cautioned that being in denial about the 4IR, which had already begun, would put South Africa at a disadvantage, leaving it falling fast behind countries which have embraced this new economic paradigm. He argued that part of embracing the 4IR is skills reorientation which in turn is forcing trusted education systems to become more flexible. Thus, the link between education and business needs to be a two-way engagement.

Mr Motsoeneng noted that understanding skills demand from a DHET's perspective needs to focus on four integrated areas, namely:

- Economy.
- Profile of the labour force.
- Current demand.
- Future demand.

He raised the following issues:

- South Africa suffers from skills deficit, and this deficit is becoming more and more evident as 4IR unfolds.
- The 4IR holds promises of gain for many, but it also requires clarity and specificity from 4IR advocates about what they really mean by it.
- Topics of skills reorientation are becoming more and more relevant, age-old trusted education systems are forced to be flexible.

Mr Motsoeneng said that a mixed methods study was conducted using information drawn from secondary literature as well as data from Workplace Skills Plans (WSPs), Annual Training Reports (ATRs) and Employer and Training Provider surveys. Information was validated through face-to-face,

in-depth interviews, and focus group discussions with key stakeholders in the sector. The study found that:

- South Africa's nominal Gross Domestic Product (GDP) at market prices in 2018 was R4.9 trillion, a R220 billion increase from 2017 (StatsSA, 2019).
- By end of 2019, the MICT sector is estimated to have a combined GDP exceeding R300 billion. This is a GDP growth forecast of 1.7% from 1.5%.
- The MICT sector is currently made up of 30,727 companies spread across the five sub-sectors.
- The Information Technology (IT) sub-sector is the largest sub-sector, accounting for 48% of employers.
- Telecommunications is the second largest at 17%
- Electronics and Advertising are tied third at 12% each.
- The sub-sector that accounts for the least number of employers in the MICT sector is Film and Electronic media at 9%.

In the MICT sector, most of the occupations are at a professional level. The number of employees is almost 2.3 million, with the largest number of employees are in Gauteng (53.1%) followed by KwaZulu-Natal (20.7%) and the Western Cape (16%).

Mr Motsoeneng then highlighted the impact of 4IR on sectors of the MICT SETA, as follows:

- *4IR impact on advertising* - In advertising, social media offers a new market for affordable content. Therefore, on social media channels, there is no substitute for influencer marketing. Print is losing traction to digital platforms. However, multimedia design skills were in short supply.
- *4IR impact on advertising in the film industry* – Marketing is lagging so much so that even South Africans don't know about films at times. Industry can learn a lot from marketing of international films.
- *Skills development* - Drone technology is now replacing the traditional cameraman, placing jobs at risk.
- *4IR impact on electronics* - Companies are shifting to leverage 4IR technologies in the manufacturing space as is evident in the MERSETA space.
- *4IR impact on ICT (IT and telecommunications and electronics)* - Skills: International companies far more advanced in IT expertise.
- *Impact of 4IR on qualifications and certifications* - High enrolment in IT learnerships and skills programs seen from 2014; now it is showing a decline in 2018 due to qualifications becoming irrelevant and outdated. The process of certification takes long whereas 4IR demands immediate solutions. Since the emergence of 4IR there has been an increase in student enrolment in courses related to science, engineering and technology.

He then highlighted the South African situational analysis, noting the following:

- There is a lack of electronic engineering skills; and difficulty in marketing products due to consumer loyalty to certain brands and mistrust of new brands.
- 4IR is eliminating the middleman and enabling users to do things without middlemen or experts, for example one can now track a car instead of paying a tracking company to do so.
- Cybersecurity is a scarce and critical skill. ICT to ICT security specialist is a top occupation in South Africa and the rest of the world.
- Globally there are 45 000 people with a Cisco Certified Internetwork Expert (CCIE) qualification; but in South Africa there are only five and this is a big challenge.
- The cost of training in ICT is expensive, the cost of a CCIE certification exam alone is ± R25 000.

Mr Motsoeneng shared that MICT SETA has 40 qualifications and worryingly, there are only 18 registered new students in 2018.

Mr Motsoeneng concluded with the following recommendations to meet the demand for skills and to close the skills gap:

- Increase skills programmes and short programmes which are regarded as immediate solutions.
- Improve access in the take up of training interventions – Set realistic targets across provinces and industries.
- Identify weaknesses i.e. monitoring and evaluation – Where are learners failing, which qualifications are being enrolled in?
- Provide funding to support Small, Medium and Micro-sized Enterprises (SMMEs) so they can be active in 4IR activities to develop more specialised and adjacent skills to help further the innovation and commercialisation of 4IR technologies in South Africa.
- Encourage local production and increased exports – Develop and manufacture for export rather than importing.

5.1.2. Implications of 4IR for Skills Supply and Demand

Presenter: Prof Babu Sena Paul, Director: Institute for Intelligent Systems – UJ

In his presentation, Professor Paul set out to answer the following questions:

- Why 4IR suddenly coming, what happened?
- What is the future of work?
- What is the skill set of the 4IR required?
- What is the shift needed in the higher education sector?

He gave an outline of the historical overview of industrial revolutions, and shared the following timelines of the industrial revolutions:

- About a century passed between the first and second as well as the second and third industrial revolutions.
- However, between the third and the fourth, there was only 60 and 70 years.
- The Fifth Industrial Revolution could happen between the next 30 - 40 years.
- 2010 - Third Industrial Revolution ends.
- 2011- Introduction of the term 4IR referring to smart factories, i.e. AI to be used in factories.
- 2015 - Term 4IR coined at WEF as AI was no longer used in confines of factories only.

Prof Paul recalled a study which stated that 90% of the world's data in 2015 was created in 2013 and 2014. This illustrated the rate of growth; and future growth is expected to be at a rate of 40% per year. According to the study, the world's data will be 163 trillion gigabytes (1 trillion means 10^{12} 10 to the power 12) by 2025. These data sources are any activity on digital devices including social media like Twitter, Facebook, emails, webpages, and online searches.

He argued that, data is the new gold, with businesses investing huge amounts of money not only in processing data but also to store, replicate and communicate data.

He noted that in there was a surge in jobs in 2010 as people were needed to make sense of the data. Before any system could be successful in any industry, what was required is capital resources, natural resources and human resources. Now success is no longer about how the capital, human, and natural resources will be used, rather it is determined by data resources.

Prof Paul quoted Sir Winston Churchill who said; *“Study history, study history. In history lies the secret of statecraft.”*

He then noted that there is a paradigm shift that is happening in the work field particularly in big data and data science sectors. He made an example of how 10-15 years ago, driving a car was a cognitive

task, today it is no longer a cognitive task because there are driverless cars. It is easy for a computer to do high cognition, high skill tasks, than for a computer to do low cognition, low skill tasks. For example, it is easy to make driverless car than to make a robot which can climb a tree and pluck a coconut. This raises questions then about whether to upskill people or increase jobs that robots can't do to keep people employed. Prof Paul then referred to the WEF's list of 10 skills required by 2020 to survive in the 4IR and highlighted the following:

- Complex problem solving.
- Critical thinking.
- Creativity.
- People management.
- Coordinating with others.
- Emotional intelligence.
- Judgement and decision-making.
- Service orientation.
- Negotiation skills.
- Cognitive flexibility.

Prof Paul explained that unlike before where one studied once and worked for the rest of their lives, this age requires a person to periodically study something new because new things are coming up. If teachers don't have this cognitive flexibility to pick up things, then the country cannot go forward.

He noted that there has been a paradigm shift in the higher education sector as some 200 years ago, only the elite in the society were educated versus current mass education. But this means education is not tailor made, and the higher education sector needs to respond to this and not continue to teach in a bulk manner.

Prof Paul then provided the following recommendations:

- Develop a professional teaching workforce with strong technology skills.
- Encourage digital fluency by embedding of technology at all levels of education and training.
- Revitalise and modernise TVET.
- Implement programmes supportive of lifelong learning.
- Provide support for education innovation through technology.
- Review the basic and tertiary education curricula.
- Nurture and develop software development, logic and programming skills as these are also very important.
- Introduce labs at school level aligned to Industry 4.0 technologies.
- Encourage online Short Learning Programmes (SLPs) and Continuous Education Programmes (CEPs).
- Invest heavily in research and development activities aligned to Industry 4.0 to drive local innovation.

In conclusion, Prof Paul detailed some initiatives being implemented at the UJ as follows:

- Short learning programmes.
- Computational Intelligence for Industry which makes students data enabled on machine learning in 48 hours. This has been running for two terms.
- Block Chains and Accountancy which is upcoming.
- Basics of Data Programming and Applications in Business.
- Digital Advertising among others.

The university has also partnered with *Resolution Circle* to train many people in a short period of time in the latest skills that are required by the market.

In closing, he noted that people who change after the change will survive, people who change with the change will succeed and people who cause the change will lead. With this said, Prof Paul noted that it is up to people to then determine whether they will change after the change or change with the change or cause the change.

5.1.3. Discussion

Questions	Answers
<p>Q1: DHET: What would you say about the quality of our lecturers in the TVET sector, are they ready to develop our students for the 4IR, or do they still lag?</p>	<p>A1: Prof Paul: Most South Africans know about the 4IR. TVET Colleges will be a success when companies come to TVET Colleges directly to recruit even before graduation. When it comes to the quality of lecturers, the question to ask is: “are they delivering what they are supposed to deliver?”</p>
<p>Q2: TVET College: Accreditation is a big problem in TVET Colleges, most of our students want to further their studies, but universities reject them because what TVET Colleges offer is not in line with what universities offer.</p>	<p>A2: The ‘revolving door policy’ is a solution. SETAs are putting TVET lecturers through programmes; they are exposing them to industry to make teaching more relevant. Skills programmes and short programmes are not aligned to the National Qualifications Framework (NQF); we are pushing to have skills programmes recognised at NQF level.</p>
<p>Q3: AfDB: How do we deal with the current paradox where we have hundreds of thousands, if not millions of unemployed people and at the same time we have thousands of jobs which are not being filled? What kind of policies can government take to try to skill people to be able to fill these jobs? Are we going to leave them behind while we preach inclusiveness in everything we do? What kind of a picture do we have in mind in the next 10-20 years? How are things going to look like if we have this huge number of people that will be left behind, the way things are going now?</p>	<p>A3: Prof Paul: I sat on a plane next to a Chinese student from Stanford, who came to Botswana to complete an internship. He wants to invest in a software company in Botswana which will work on AI and machine learning. He could not find a suitable employee; it was not a question of money; no-one had the skills.</p>
<p>Q4: King Hintsa TVET College: Since there are some skills that are in short supply, how often do you do this research to determine those skills? Do you conduct research in terms of employability?</p>	<p>A4: NSA: We conduct research annually to identify skills that are in short supply; there are also quarterly mini reports. We engage with our stakeholders, employers and training providers. We do tracer studies or impact studies annually to see whether we are making an impact. From a tracer study perspective, it is to see whether people are being absorbed into the labour market because of our programs. An impact study is at a higher level. We usually do tracer studies because tracer studies look at your period from three years going upwards; impact studies are more complicated because that is where you look at the deeper changes in the community. Tracer studies look at your achievements as an organisation, and if there are people the labour market is absorbing.</p>

Q5: Capacity Building Program for Employment Promotion Project: Is there any attempt to come to grips with the realities of our existing educational system? Many students through no fault of their own are severely disadvantaged in terms of their educational background. We talk about a transformation of the workplace, of the economy and social relations, but the current reality is our educational system is failing our young people. We have this vision of a city on a hill, but our reality is a long way from that. What is the transformational potential of the 4IR itself of these new technologies, approaches, in terms of, helping us leapfrog some of these higher education systems, helping to address the shortcomings of the teachers we have? We have young people who are totally at home with cell phones and other technologies, how do we harness some of these things to perhaps bridge some of the gaps that we face?

A5: Prof Paul: We need to bear in mind that the country is only 25 years young. We are educating a huge number for the first time. The National Student Financial Aid Scheme (NSFAS) is one of the beautiful things we have done in education. Another beautiful thing is that 90% of South Africans have electricity. Now we can think about taking the 4IR to the village even, to the clinic that is in the village because that is connected to electricity. Another is the coverage of data. In the last 2-3 years, the number of secure servers in South Africa has grown drastically, and according to the World Bank is higher than the world average; this is building the ground so that you can take things to the people.

Comments

C1: DHET: As the DHET, we want to understand how the world of work is changing in terms of skills supplied and demand. We have a programme where we are trying to identify the type of skills that will be needed for sustainable livelihoods and the informal economy. We need our people to create jobs, and also through our CET programmes, training colleges and TVET Colleges. We will be offering entrepreneurship; we want to promote the idea that people must start to create employment for themselves.

C2: Local Government Sector Education and Training Authority (LGSETA): Workplaces need to be more responsive in terms of how they use learning for continuous improvement. The issue is not whether it is the fourth, fifth, sixth or seventh revolution, but how are we continuously looking at the relationship between identified skills and appropriate interventions? We spend a lot of money on training; when you get back into the workplace it is sometimes very difficult to make the necessary changes in the workplace. If we do not make the changes, what happens to that training? We need to use evidence-based research to improve the continuous improvement of learning in the workplace. Unless we do so, we are investing a lot of money, but we are not getting the impact. We need to make linkages. We have the National Development Plan (NDP). What are we doing, how are we making an impact, how are we using the youth? We need to collaborate on human resource development and how we tie up the gaps.

C3: Prof Paul: Education and industry need to come together. Why is the USA successful? There are people from the industry sitting in Stanford; this synergy is not happening in South Africa. Unless we have this synergy, we will be left behind.

C4: Surveys reveal that most employers prefer to do up-skilling or training in house. Perhaps DHET or the SETAs should start directing the use of their SETA discretionary fund to retrain and up-skill in the workplace. The private sector needs to invest in developing private skills sector training institutes that would conduct the type of training that is required.

C5: DHET: DHET produces a list of occupations in high demand every two years. We communicate with SETAs. We also issue a call for evidence where we allow all stakeholders, employers, to indicate the kind of occupations in demand in their particular sectors. We are also working closely with the Department of Home Affairs to develop a critical skills list to assist Home Affairs in terms of getting the people with the relevant skills that we cannot find in South Africa in the short-term.

5.2. Breakaway Commission B: Using Technologies to Improve PSET

Facilitator: Dr Whitfield Green, Chief Director: Teaching, Learning and Research Development – DHET

Scribe: Ms Refiloe Mohlakoana, Assistant Director: Policy, Research and Evaluation – DHET

Dr Green facilitated the breakaway session which was aimed to explore opportunities for the use of technology to improve the PSET system. The session engaged industry experts on ways in which the PSET can be improved.

5.2.1. PSET as a Digital Ecosystem

Presenters: Dr James Keevy, Chief Executive Officer (CEO) – Joint Education Trust (JET) Education Services, and Dr More Manda, Senior Manager: Strategic Planning – MERSETA

Dr Keevy and Dr Manda jointly presented the work they are doing in exploring digital interoperability for the PSET system.

Starting his part of the presentation, Dr Keevy explained that interoperability is linking digital systems to each other, developing a platform that enables users to share and use data for decision-making to enable a more efficient and responsive post-school education system.

An Application Programming Interface (API), for example, is like a bridge between two different data systems. Instead of developing new databases or systems, Dr Keevy suggested the development of platforms to connect these data systems.

Dr Keevy noted the following challenges:

- Varied range of different systems of data systems in key sectors in South Africa.
- Data systems are fragmented, they don't talk to each other. There is limited data sharing.
- Those that are linked can be strengthened.
- Is there clean, reliable data?
- Lack of capacity of data captures.

Dr Keevy shared that for the past year MERSETA and JET Education Services have been working on interoperability. This started with a situational analysis by the CSIR and a mapping study of all networks and how they can be more interoperable.

He noted that the international review found a range of models; as follows:

- Michael & Susan Dell Foundation – Data sharing for K12 education decision making.
- OpenFn – Middleware rule-based automation. Reconciliation of data sources as they move through.
- Grönigen Declaration Network – Ownership of data by end user Right to share data wherever they want.
- SDMX and Stat – Organisation for Economic Cooperation and Development (OECD) Tools for collection, processing and dissemination. Open APIs and rich data experience.
- Data Driven Districts – Intuitive dashboard, Visualise the South African School Administration and Management System (SA-SAMS) data, Ed-Fi data standard.

Dr Keevy highlighted that the SETA system has information management systems including the National Learners' Record Database (NLRD), with millions of learner achievements on that NLRD, which is linked to other systems.

Dr Keevy highlighted the following key issues, for consideration:

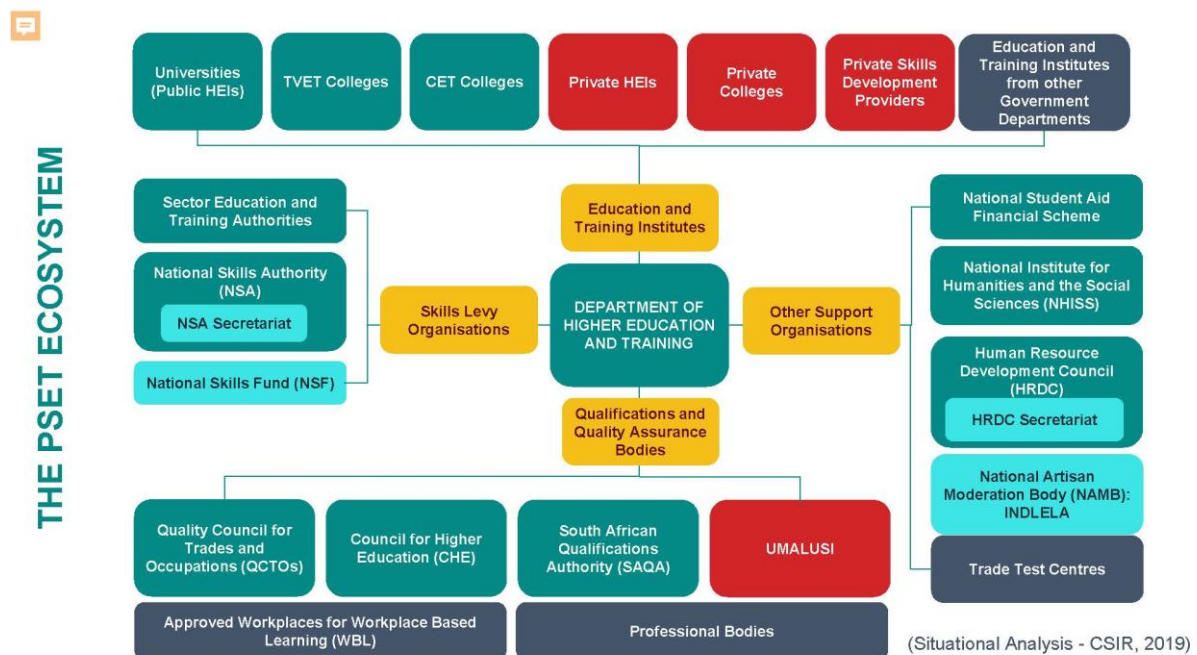
- When does a learner come out of the schooling system?
- What qualifications do they have / what did they learned during that period?
- What are their preferences?

- How can they be better given career advice?
- What are the struggles of finding employment?
- How can job-seeking graduates be linked to the labour database, effectively creating a supply and demand ecosystem?

Dr Keevy then noted the following levels of interoperability:

- Technical Infrastructure – Where the data lives? i.e. Cloud, Server, and Ledger.
- Data – Qualitative / Quantitative and structured / unstructured.
- Organisational Practices – Collaboration and incentivisation.
- Institutional, Law and Policy – Accessibility, Privacy and Human Rights.
- Humans – Knowledge and education.

Below is the PSET Ecosystem situational analysis presented by Dr Keevy:



Concluding, Dr Keevy said South Africa does have resources but not always the ability to spend them. This was most evident with the problem of unemployment where the country continued to focus on oversupply and less on demand.

Taking over from Dr Keevy, Dr Manda highlighted the following key questions.

- What kind of data should be collected?
- Is the infrastructure ready?
- Where should the data be stored, on a Cloud?
- What are the privacy, and human rights issues arising?
- Who will have access to store the data if it is owned by the government or private entities?
- What are the restrictions?

Interoperability would allow for stakeholders to be identified and for each to know the other's systems and their challenges.

When mapping these out, Dr Manda said there was a need to look at the supply side as well as the demand side, and not just at the technical or operational levels but also at strategic levels looking at any issues which may affect decisions or issues around policy.

Fortunately, their analysis of the legal and policy framework revealed that there were no barriers to having an interoperable PSET cloud system in South Africa.

In closing, Dr Manda noted that there are no barriers preventing South Africa from setting up an interoperable PSET Cloud system, but there are questions around the technical aspects. These are in terms of proliferation of open learning initiatives, of a lifelong learning which is uncoordinated and learners not being able to access information easily. From a governance side, it should provide an enabling framework to set up the relevant standards as well as the resourcing for infrastructure. The policy framework supports the principles of the NSDP, all these policies in terms of the NDP, the White Paper for PSET, the Higher Education Act and the South African Qualifications Authority (SAQA) Act. These are all the policies, some of which were reviewed as enabling framework for setting up the PSET systems.

5.2.2. 4IR as a Driver of the PSET Applications Process Technology

Dr Salamina Dzingwa, Senior Deputy Registrar – Vaal University of Technology (VUT)

Dr Dzingwa presented her Doctor of Philosophy (PhD) study which evaluated the effectiveness of the centralised application systems in South Africa, in the backdrop of the number of inefficiencies.

One of the major roles of higher education is to curb youth unemployment, thus Higher Education Institutions (HEIs) have experienced a high demand for access. As a result, they are faced with inefficiencies and ineffectiveness in the management of applications for admission to the sector. An aspect of the NDP Vision 2030, as related to this study, is the desire to have a developed country with an HE system that will enable its citizens to fulfil their potential and encourage economic growth and development. A number of policies govern public institutions, which inform the regulation of HEIs that address inequalities. Her research aimed to evaluate if the Central Application Service (CAS) is a fit system for South African HEIs and the viability of the implementation of the PSET CAS.

In KwaZulu-Natal, a non-governmental organisation Central Applications Office (CAO) runs a centralised system for the submission of all applications to universities, TVET Colleges and government tertiary institutions. As such, research showed that the participants – 300 students – came from the DUT and the University of KwaZulu-Natal (UKZN). Dr Dzingwa also interviewed CAO staff.

Dr Dzingwa noted the following challenges:

- Access to technology/computers – There is an indication that there is still preference for the manual ways of doing things. Also, data charges to use the internet raise questions of affordability.
- Lack of synchronisation of systems used by HEIs.

Dr Dzingwa provided an outline of the South African Policy Framework and highlighted the following:

- In 1997, the Department of Education (DoE) developed the White Paper 3 on higher education, to address the challenge of massification of higher education, and more importantly to focus on the redress of the unequal state of or education system to a more integrative one. The conceptualisation of the CAS grew out of the aims of this White Paper.
- The Higher Education Act 101 of 1997 was put into law. This Act facilitated a single coordinated sector for the higher education sector. The Act regulates the establishment of the governance structures and funding of the HEIs, and the composition as well as the functioning of the Council on Higher Education (CHE). The Act also refers to the registration of private HEIs.
- In 2001, the DoE developed a Draft National Plan for Higher Education (NPHE) in South Africa designed for the higher education system to achieve its transformation objectives set out in the White Paper and is responsive to societal interests and needs. The plan is set to develop a higher education system that will 'promote equity of access and fair chances of success to

all who are seeking to comprehend their potential through higher education, while eradicating all forms of unfair discrimination and advancing redress for past inequalities' (p.6)

- In 2005, the DoE introduced the minimum admission requirements for Higher Certificate, Diploma and bachelor's degree. The policy outlines the statutory minimum admission to Higher Certificates, Diplomas and Bachelors' degrees the National Senior Certificate (NSC) from January 2009. This is applicable for both private and public HEIs. Admission requirements are fundamental to the operation of the CAS.
- In 2016, the DHET introduced a policy for the PSET central application service. The policy provides legislative context to the establishment of the CAS for the DHET. Dr Dzingwa explained that the CAS is the case under study in her study.
- In 2008, the NQF Act, 2008 (Act No.67 of 2008) was enacted to provide for the NQF. SAQA and the Quality Councils for qualifications and the quality assurance of these qualifications required.

Dr Dzingwa made the following recommendations:

- Consider current issues (NSFAS funding, PSET sector) and then close the gaps in processes.
- Create an enabling environment to support 4IR.
- Focus on solutions that will address technology shortfalls, including skilling to students/staff.
- Bring technology to the people (e.g. DHET partnership with We Think Code, a non-governmental organisation (NGO)).
- Bring electronic applications services closer to prospective students – service centres, hubs etc., particularly in high schools in rural areas.

In conclusion, Dr Dzingwa called for the realities which are a challenge to, and those which arise because of, the 4IR, to be adequately addressed.

5.2.3. Learning Management Systems in TVET Colleges

Presenter: Ms Carol Dwyer, Manager: E-Learning – False Bay TVET College

Ms Dwyer shared her experience of learning management systems at the False Bay TVET College. Bemoaning the fact that the 50 TVET Colleges in South Africa all use a different system, she highlighted the need to identify a uniform system that can be customised by all TVET Colleges, not a one-size-fits-all system, but one that can be used as a standard benchmark system and be customised for each TVET College.

She shared that False Bay College uses a customised system which allows their students six campuses to access information and communicate with lecturers. Two more online campuses were being established.

In 2008, the college's executive management started implementing a strategy towards meeting the 4IR.

Ms Dwyer noted the following three areas of development:

- Student support – Designated student support officer who is a qualified counsellor or psychologist.
- Occupational therapist – Based on campuses that help with any inclusive education or special needs education.
- E-learning – established an e-learning department.

To operationalise, they needed a structure / processes, to prepare, finance and invest in human capital.

Further the college established open learning centres / libraries with Wi-Fi access and a learning management system, hosted by the college, albeit at a hefty price. This as open source learning

systems are not free and there is a lack of IT infrastructure and expertise – IT technicians at each campus, responsible for ensuring that a teaching, learning and the operational capabilities of the organisation continue.

Ms Dwyer noted how the college uses technology as a tool; as follows:

- eBays or computer labs in each open learning centre for online learning, online lessons, where students can do quizzes and answers which are used to assess level of comprehension.
- Online video notes with web tags.
- Kitchen demonstrations and cameras in kitchens to teach hospitality. Content loaded onto the value management system and e-learning system.
- Online assessment for distance learners, full time and part time learners.
- 60% of online assessments to be marked automatically, 40% by lecturer.

In conclusion, Ms Dwyer raised concerns around how the 50 TVET Colleges and CET Colleges are operating in silos and competing against each other rather than collaborating, as they are all there for the benefit of the students and the young people of South Africa.

5.2.4. Discussion

Questions	Answers
<p>Q2: DHET: Where is the Intellectual Property (IP) line that will integrate the different systems to provide services to users as if they are on one coherent system? What are the issues in that regard?</p> <p>With the different data sources that you have, you are going to generate new data. Where does the ownership lie of that data?</p>	<p>A2: Dr Keevy: Blockchain and these technologies enable us to have the origin of the data source to actually authorise these. Ownership is going to be something that we are going to be talking to government about. Ownership is going to be the issue before service, but the international trend is showing us where that is going. It's all about data protection and strengthening our data protection policies and allowing the learner to own his or her own. How we get there might take some time.</p>
<p>Q3: If our systems are a mess, how are you going to intervene and assist in terms of streamlining processes to assist administrators and lecturers, at the same time making sure that the main objective of teaching and learning progresses?</p>	<p>A3: Dr Manda: In terms of this whole notion of the PSET cloud ecosystem, this is a platform that is going to enable our various systems to communicate with each other to exchange data. We are not saying the PSET cloud system will become a universal system which will integrate all the systems, be it in the TVET Colleges or the higher education system. It's IP in terms of who actually owns the platform. This was one of the key issues that emerged from the study. Is this a system that is owned by the government? Is it the DHET – should it be hosted or should it be owned by the DHET; should it be owned by a private provider, for example, because they might have other intentions? At the moment, you talk about people's data. There might be other intentions, other unintended consequences that will happen if the data or if the systems are hosted and owned by a private provider; there were also concerns around ownership by the government in terms of the</p>

	<p>bureaucracy. This is a question that we still need to answer as the study unfolds. One of the findings was that in terms of us as South Africa, when looking at issues of data, IP, who owns the data, who owns the system, not just from the moral side of things but from the legal side of things as well? We have legislation and policy that governs information and data, for example the Protection Of Personal Information (POPI) Act and things like that. So, all those will obviously determine who will host or who will own the system.</p> <p>A1: Ms Dwyer: There's always going to be policy that will constrain you on various things. For example, there is something like own assessment. TVET Colleges have been requested to do distance learning but the policy with regard to DHET still constrains TVET Colleges from doing 'proper' distance learning. There is a need to relook assessment policies. Assessments are always done online. In terms of summative assessments – there is a need to follow the policy completely, and then the DHET is to correlate, and TVET Colleges still have to do the same thing. There is a need to find ways to work within that policy and some courage will be needed when policy change does come, there are people who are doing things differently and they can actually see that when they start looking at policy changes.</p>
<p>Q4: Do you think that our CAS will work or not? Most universities have online applications that students don't know, so where are they getting access to the documents?</p>	<p>A4: Dr Dzingwa: There is a preference for the centralised model. Most of the participants are finding that it is a well-oiled machine via the CAO, and they are happy with it, with specific recommendations that they are making to improve the process moving forward. As institutions we are not all on the same level when it comes to technology. VUT is not even near online application or online registration, we are still battling with some of these little things. Our students are still in queues half the time. There are a number of complexities that we need to shape our processes and make sure that when we do this we consider the disconnect. We can have a dual process with the CAS online so that we don't exclude anybody from accessing higher education. Ultimately that is the goal. We do not want them to feel left out because of a technological advancement. So yes, there is preference for the CAS; however, we need to support the journey moving forward.</p>

Comments

C1: DHET: When we look at the smart built technology, we find these days that our data projectors are Wi-Fi capable, so I encourage more engagement with the learner through their devices. Around the zero rating, it's easy to go to MTN, Vodacom and so on. My suggestion would be that you have one platform where possibly all your content resides; you engage with Independent Communications Authority of South Africa (ICASA) to say this is an educational platform. When we have our resources, we would like to zero in on that.

C2: Ekurhuleni TVET College: Regarding ecosystem or interoperability, we have about six / seven campuses; we need one assessment policy; we need one assessment in terms of the same systems. Like Ms Dwyer said, colleges should be using a system which is working towards a single objective. We are not supposed to be competing.

C3: A national open learning system is currently being developed; it will have a repository of learning materials – at the same time certain learning materials are being developed centrally so that all colleges can share it. CSIR has come around, but there is a need to talk because things are moving very fast, and engagements must start and be prioritised. There are already linkages with internal systems. But they are still fixing each of these systems; because they are new, and there isn't enough staff we don't have sufficient staff, and everything starts from what happens in the college. It starts from that application core and it starts with the whole value chain from the college by the time you could just ask. There are risks every step of the way. We can't wait to have everything fixed completely; we can start with linkages. With the use of the National Learners' Records Database (NLRD), I have some doubts on it. We are the owners of much of that data, we have the exam system, and it's an administrative system. By the time the data goes to SAQA or through three other partners, you are losing stuff along the way. Go to the original source.

The NLRD is a tertiary source, and we are already linking it with your enrolment data. The NLRD only has completion data, not enrolment. Another key issue, we must get legal advice about the POPI and about issues of licensing and maintenance of software and platforms and costs, otherwise nothing is sustainable. And the issue of costs must be with an organisation that's going to continue to exist, which is the government department, because the name could change but it will still be there. Then also just to share with you the other initiatives already happening.

5.3. Breakaway Commission C: Workplace Readiness in the Context of 4IR

- *Facilitator: Ms Melissa Erra, Chief Director: Strategy, Innovation and Organisational Performance – National Skills Fund (NSF)*
- *Scribe: Mr Simo Zulu, Deputy Director: Policy, Research and Evaluation – DHET*

The session was facilitated by Ms Melissa Erra. The session focused on various case studies on workplace readiness and preparedness within the context of the 4IR. Speakers identified opportunities, advantages and challenges that 4IR poses to the work environment.

5.3.1. Organisational Readiness to Implement the 4IR: A Case Study at Two Local Municipalities

Presenters: Dr Harlan Cloete, Extraordinary Lecturer: School of Public Leadership – University of Stellenbosch; and Ms Karabo Moloko, CEO – CoLAB Project Implementation

Dr Harlan Cloete and Ms Karabo Moloko presented a case study that had been conducted at two local municipalities. The case study was premised on the understanding that South African municipalities have been plagued with poor service delivery, limited capacity and constrained resources.

Dr Cloete stressed that the point of research and publishing papers was to improve quality of life. He outlined the methodology that was used on the case study. Questionnaires were sent to senior managers, Human Resource (HR) practitioners and trade unions. Indicators regarding people, change management, risk management, culture, customer care, strategy and leadership were identified.

Ms Moloko explained that 4IR offers the public sector potential to leapfrog and accelerate delivery of key services through digitally enabled solutions.

Ms Moloko noted that 4IR can enable the following:

- Accelerated delivery of services.
- Increased access to services.
- Improved community participation.
- Greater social accountability.

She added that the case study assessed the following:

- Municipalities' readiness to implement and leverage the 4IR.
- Which dimensions require reinforcement to ensure successful implementation of digital capability?

It was also noted that the study considered areas of:

- Strategy and leadership.
- Customer care.
- Municipality culture.
- People.
- Risk management.
- Change of management.

The study found that:

- There was general consensus that leadership and municipalities understand 4IR and the role and the opportunity that it brings to them.
- There was a lack of clear initiatives towards digital implementation in municipality development plans.
- Leadership and decision making was not fully based on empirical data evidence. Municipalities are not using big data to drive priorities and decisions. One of the fundamental characteristics of 4IR is big data and data analytics.

Dr Cloete added that some of the comments they received from managers included:

- Lack of communication by the municipal leaders to sensitise subordinates about 4IR.
- Management was resistant to change.
- Most managers spend less than they are expected to so they can get performance bonuses.
- Municipalities need one reporting system. Managers have more than 20 reports that they must comply with. There is an opportunity for one seamless reporting system to be introduced.

Ms Moloko noted the following recommendations from the case study:

- 4IR must move to execution.
- Roadmaps must include 4IR initiatives.
- Data must inform priority programmes.
- Data must be used to improve service and solutions, with direct engagement with customers for solutions.
- Leadership change – management initiatives must be prioritised to fast track adoption of 4IR.
- There is a critical need to map technology changes against jobs and skills that are being disrupted. Need to skill and reskill employees.
- Urgent initiatives are required to prepare the organisations for the imminent changes. This includes awareness of 4IR as well as impact on individuals.

Dr Cloete concluded that municipalities need to focus on data gathering, evidence management, then turning that evidence into information knowledge which leads to decision making.

5.3.2. Exploring How Work Integrated Learning (WIL) Can Be Used as a Catalyst to Prepare Bachelor of Commerce (BCom) Degree Students for the 4IR: A Case Study of the University of the Western Cape (UWC)

Presenter: Dr Karen Dos Reis, Senior Lecturer and Teaching and Learning Specialist: Faculty of Economic and Management Sciences – UWC

Dr Dos Reis presented a pilot study that she conducted at the UWC, and the WIL model she developed for B. Com degrees as well as Public Administration students in order for them to develop creativity, communication and collaboration. The development of the WIL model was against the backdrop that graduates emerge poorly prepared for the realities of the workforce and often find that companies are not willing to help them build practical experience.

Dr Dos Reis was concerned that the 21st century graduate was expected to be creative, have communication skills and be able to collaborate well with others, but where were they learning these skills? Was the assumption that these skills are embedded in the formal curriculum, if so; how? The other concern was that these students, while they are studying for the first three years, never connect with the world of work. That is a cause of concern, because how do they then implement theory with practice?

The WIL model encompassed:

- Work readiness awareness workshop –The first tier of the WIL Programme exposes students to a workshop that aims to create an awareness of employer expectations of the workplace.
- Peer mentoring – The second tier of the WIL Programme requires students to participate as mentors to first year students in the discipline-specific peer mentoring programme. This will assist the students in developing the 21st century skills of learning to assist someone else.
- Volunteerism – The third tier of the WIL Programme exposes students to volunteering opportunities in order to build civic responsibility and selflessness.
- Job shadowing – Exposes students to different business practices and staff roles within the organisation.
- Short term placement – Focuses on giving students exposure in organisations within their discipline.
- Internships – In the final tier of the WIL Programme students could be offered an internship after graduation.

Dr Dos Reis questioned why internships were offered to graduates instead of being offered earlier on when the students are still working on the course. In that way, students are trained in the world of work for a shorter period of time, and when they do graduate, employers already know about them and they have acquired market related skills.

5.3.3. The Effect of 4IR on Tertiary Education

Presenter: Prof Nelishia Pillay, Head of Department: Computer Science – UP

In her presentation, Prof Pillay outlined that AI has been used in education through:

- Automated tutors and teaching assistants:
 - Intelligent tutoring systems.
 - Automated teaching assistants – Jill Watson.
 - McGraw Hill SmartBook 2.
 - Pearson Mastering – personalised feedback.
- Automated Assessment:

- Essay marking.
- Pearson – writing, speaking, mathematics.
- Assessment of surgeons in training.
- Psychometric testing.
- Talent assessment.
- Educational Data Mining and Learning Analytics:
 - Predicting student success.
 - Predicting learning difficulties.
 - Blackboard predictive analytics.
 - Identifying success factors for schools.
- Designing Learning Environments:
 - Web-based courseware.
 - Digital learning environments.
 - Online course.
 - Creating pedagogical agents.

She noted that AI can be used for educational data mining and learning analytics, so predicting students' success. AI can be used to predict whether a student will fail or pass. This allows universities and lecturers to pick up early on when a student is struggling and provide interventions such as additional tutoring.

Speaking about whether degrees should be offered in AI, Prof Pillay argued that not everybody has the aptitude or the sort of excitement about programming or AI; experts should actually create the artificial tools and they should be doing the coding. She highlighted that what needs to be put into curricula, however, is how AI can be used in the curriculum.

She noted that, of concern is the fact that there hasn't been enough planning ahead regarding the implications of the 4IR; as people are going to lose jobs, just as was the experience with previous revolutions – but what is going to happen to those people when that happens? She argued that this is the time for planning, and AI should be used to plan for the skills shifts. Skills shift needs to be done beforehand and be decentralised at specific industries, but also at a national level.

Some of the challenges that Prof Pillay identified include:

- Limited use of artificial tools in education.
- Lack of acceptance of AI conclusions/decisions.
- What happens if something goes wrong?
- Impact on Sustainable Development Goals (SDGs):
 - Lifelong learning.
 - Employment for all.

In closing, Prof Pillay said AI offers a lot of potential in education in that not everyone should become an AI expert; and they need adaptability and critical thinking.

5.3.4. The Effects of 4IR on Africanisation as an Emerging Global Trend in Higher Education

Presenters: Dr Fabian Nde Fon, Ruminant Nutritionist: Faculty of Science and Agriculture – University of Zululand (UniZulu); and Dr Melusi Sibanda, Lecturer: Faculty of Science and Agriculture – UniZulu

In the presentation, Dr Nde Fon explained how the 4IR can affect and influence Africanisation in the context of higher education. He emphasised that technology is moving at an incredibly fast pace for humans. For South Africa to keep up there is a need to move to a knowledge-based economy. He highlighted that there is a need for people to actually influence technology and harness the potential of AI; and further be aware of their environment to deal with uncertainty and complexity of the 4IR.

Dr Nde Fon explained Africanisation of 4IR as a concept of accommodating the indigenous systems within 4IR. It is about using the technology to meet people’s needs and not only focusing on international standards. He emphasised that there is a need to manipulate technology to respond to African environments, enhance community development, provide real solutions to the challenges that people have. Technology must be context relevant and acknowledge indigenous knowledge systems.

Discussing the paper, Dr Sibanda, highlighted:

- Intelligence, robotics, and technology have to include the processes that are involved – the policies and media reviews, for example.
- The medium of teaching and learning in an African university:
 - Structural design.

The paper identified the following 4IR advantages to African universities:

- An opportunity for digital higher education to be more affordable.
- Availability of eLearning materials and eTextbooks.
- Opportunities for innovation and creativity.
- Opportunity to enhance interactivity – Content and material that will be meaningful to learners which involves problem solving, critical thinking. 4IR also promises to enhance the handling of diversity and learner links.

He noted the following challenges of the 4IR in African universities:

- 4IR cannot be discussed without commodification of knowledge.
- It creates the dual challenge of digital divide, increasing gap of access, affordability.
- Limited infrastructure.
- Difficulty in terms of regulating bad practices such as cheating.
- Current curriculum doesn’t match the 4IR skills that are needed.
- Threat of cyber security.

Dr Sibanda concluded with the following recommendations:

- Develop 4IR specific policies that address:
 - Specific type of technologies.
 - Sustainability of technology.
 - Relevance to communities.
 - Curriculum in terms of teaching and learning, assessments, moderation and evaluation.
- Invest in research to inform policy development.
- Invest in technologies that will enhance community development using African knowledge systems for innovation and acknowledging African use.
- Leverage technologies that will tackle African issues.
- Explore issues around ethics of the 4IR.

5.3.5. Discussion

Questions	Answers
<p>Q1: Facilitator: My question is probably linked to data ownership, data privacy and data confidentiality. We’ve been doing a teacher supplier demand study, and simply getting the permissions in place so that we can get the database that we need to do the analysis has been a nightmare. How do you, in an</p>	<p>A1: Dr Dzingwa: Caution must be taken not to oversimplify what is being discussed, because there are embedded issues, especially when it comes to access. While talking about data and data ownership and so forth, it must be noted that as HEIs, there are a number of complexities that must be dealt with. Competition is one of the issues. Students have a preference for specific issues. So those are the dynamics that</p>

interoperable platform, address the issue of data confidentiality?	we are going to need to deal with. So how the issue is about moving away from the work phenomenon, for example, using the system, the technology? For institutions, there is a need to collaborate and build confidence of the use of technology from the bottom up.
Q2: Will this involve reinvention of current systems?	A2: Dr Keevy: There has been talks with all players around this and the point to take is that this is a system of systems, it's high level. It's not a reinvention or replacement of a system. It must be raised that there is a lot of politics involved around this, because there are also histories around things that have been done. There is a need to unlock resources and capacity for government, by so doing, we can make progress. Through this initiative there is potential to unlock both local and international capacity; but there is no need at all to replace what is being done.
Q3: Can we extend your learning management system at False Bay TVET College to all the TVET colleges?	A3: Ms Dwyer: Consultation is a big concern. Something is being developed for electricians that was supposed to be available in June this year; and still not available. If there are people who still don't know about NSS that means that once again there's a side on operability that is happening, that is not being communicated. The concern remains around consultation of the TVET Colleges; regarding their exact needs, not just the assumption that all TVET Colleges need the same thing. A privacy lecture on data privacy was recently conducted by the False Bay TVET College, the survey requested some confidential information from lecturers, and some lecturers were upset that person questions were being asked, such as Identity Document numbers and things like that? Others wanted to go to the unions, because they wanted to know what the information was going to be used for and wanted to understand how the DHET was, if at all, going to use that information, they had concerns around whether they were qualified to teach or not. So data privacy and data protection is not just from the side of the institution, it's also that individual understanding and almost the sense of – perhaps conspiracy, but it is not conspiracy – it's that fear that lecturers have – around what information is being used for? That was one of the concerns that came up; and this needs to be carefully thought out, lecturers are very sensitive about their information.

6. DAY TWO: THURSDAY 19 SEPTEMBER 2019

6. Session 6: International Perspective

Programme Director: Ms Trudi van Wyk, Chief Director: Social Inclusion and Quality – DHET

The Programme Director welcomed all the delegates to Day 2 of the 6th annual Research Colloquium on the 4IR and its implications for PSET. She then summarised the proceedings of Day 1 before introducing the first presenter for Session 6.

6.1. Embracing the 4IR: An International Perspective

Presenter: Dr Marieke Vandeweyer, Labour Market Economist: Employment, Labour and Social Affairs Directorate –OECD

Dr Vandeweyer gave an international view of the 4IR. Using evidence from the OECD countries and, where possible, she also added South African data highlighting the importance of access in digitisation. She said that there is a need to recognise that if there is going to be benefits reaped from the digital transformation of the 4IR, there is a need to ensure that people have access to technology. Sharing some research around access, she said it is estimated that by 2022 for each person there will be three connected devices; and noted that access to technology differs between households in rural areas and urban areas. In rural households only 56% of households have access to fast fixed broadband, compared to 85% in urban households. She noted progress in the use of technology, highlighting that a lot of people are using their smart phones mainly for personal use. With this in mind, there is a need to move beyond basic uses of technology and move towards the more sophisticated use, for example 74% of people use e-mail, but only 9% of people take an online course; therefore there is a need for better use of technology in this regard.

Speaking about innovation, Dr Vandeweyer noted that innovation is driving digital transformation and a lot of investment is happening in digital technology. In fact, one-third of business expenditure goes into the IT industry and 12% of private equity investment goes into AI.

Dr Vandeweyer shared that a lot of this digital transformation is having an important impact on jobs. In OECD countries four out of ten jobs created in the last couple of years were in highly digital-intensive sectors. There were big changes in the structure of the labour market. In the last 20 years, manufacturing sector employment declined by 20%, while most of the growth was in services. She noted that, robots are really coming; 14% of jobs in OECD countries could be entirely replaced by technology.

She argued that the positive aspect is that overall employment has been increasing globally on average, so it is not true that technology is reducing employment. While technology is destroying some jobs, it is over-compensated by jobs that are being created because of technology.

Speaking about the impact of digitisation on jobs, Dr Vandeweyer noted that jobs in the middle of the skills distribution or wage distribution (routine jobs) are being replaced by technology. Growth has been mainly in high skill jobs. In South Africa there has also been growth at the lowest levels.

She said that in the next 10 to 20 years there is a need to try to estimate the degree of automation of different jobs to establish which tasks can be automated. In the OECD an average of 14% of jobs have a high risk of automation and 32% of jobs have a medium risk. Some of the tasks will be automated but not all, so these jobs won't disappear but will change drastically. Speaking about high risk jobs that will be exposed to the highest risk of automation, she noted that those tasks that involve a lot of routine will be the most affected; these are medium to low-skilled workers. High-skilled and some middle lower-skilled jobs have a low risk of automation because they carry out very social interactive skills and tasks where they interact with other people, and this is difficult to automate.

Dr Vandeweyer highlighted that of importance to note is the rise of non-standard work and to understand that the type and content of jobs is changing, as is the way that work is carried out. The rise of platforms that bring together workers and employers like Uber, and freelance platforms like Fiver and Upwork, are only possible because of technological progress, and this in turn is driving trends towards the adoption of non-standard work. In OECD countries, one out of nine workers is in a temporary job, one out of seven workers is self-employed and one out of three workers is non-standard; these workers do not have social benefits.

She highlighted that the policy response to digitisation and automation should consider the following:

- *Skills* – People must have access to the appropriate skills development opportunities, but also job security. There is growth in higher-skilled jobs and good quality jobs but many in the OECD countries have low levels of educational skills (including South Africa).
- *Training* – To access the right type of training is very difficult. There is a need to align training to skills needs. Even at the employer level it is difficult to align training needs and the training provided.
- *Adult learning and future readiness* – There is a need to reduce the barriers to access. Training policies need to be flexible (modular or part-time programmes and evening courses to help people balance their time). Costs must also be reduced.
- *Alignment* – Information and skills needs must be used in designing learning policies, and also to identify who are the workers who need training the most.

In closing, Dr Vandeweyer noted that there are a number of opportunities that come with digital transformation, and these include growing the number of teachers who are using digital technology in the classroom, and leveraging digitisation for adult learning through digital courses that provide more flexibility for adult learners.

6.2. Leveraging Digital Platforms to Accelerate the Creation of Economic Opportunities: Insights from Saudi Arabia

Presenter: Ms Kirsty Chadwick, Group CEO – The Training Room Online (TTRO)

Ms Chadwick revealed that when she arrived in South Africa from New Zealand, she was struck by the inequality in education in South Africa. She established TTRO to use technology to enable a different way of teaching and learning, taking a future view of what learning might look like if technology was enabled to be part of that journey. She highlighted here experiences have taught her that the future of work is harder and faster than expected. There is disruption in every sector and in every industry.

She noted that research shows that 65% of primary school children will work in jobs that do not yet exist, yet one of the biggest challenges is that education has been slow in keeping pace with what is happening in industry. This means, there is a need to rethink the way curricula is designed and begin to strategically with industry about the kind of skills they need today and, in the future, to prepare learners for these future jobs.

Ms Chadwick emphasised that there is a need to re-look what they are doing in basic education and even ECD. Lifelong learning needs to be stronger than ever before. She said, of importance to note is that 4IR will provide more opportunities for better jobs if people have the right kind of skills.

Ms Chadwick who has also established operating companies in the United Arab Emirates (UAE) and Saudi Arabia shared the following insights on 4IR in Saudi Arabia:

- The 4IR is driving unprecedented change in Saudi Arabia.
- Saudi Arabia plans to achieve its Vision 2030 by using 4IR tools.
- Saudi Arabia has built its vision around nine pillars of the 4IR and the disruptors.
- TTRO operates inside a capability centre for industry four within the King Abdulaziz University for Science and Technology.

- There is a capability centre that showcases what industry 4.0 looks like.
- Industry 4.0 is not a sector but a practical technology that underpins every sector.
- The Kingdom has *Vision Realisation* programs with defined and specific initiatives and projects with tangible, measurable outcomes under a performance agency called Ada.
- Industry 4.0 covers the mining industry, manufacturing, logistics and energy.
- Education and workforce development are aligned to the move into the 4IR.
- The vision realisation program looks at talent development across the nation of Saudi citizens and beyond from early development to post-retirement.

She also noted the following lessons from Saudi Arabia:

- There are five capability centres in the kingdom and research-and-development, small-medium enterprise and education are linked.
- Many players within the ecosystem are collaborating, enabling the kingdom to transform.
- Public-private partnerships play an important role in enabling the success of the ecosystem.

Ms Chadwick noted that as South African starts and continues to engage around 4IR, there is a need to build capabilities centre aligned to the industrial and economic opportunities within each region. There is also a need to upskill people for these jobs. Small enterprises need access to mentors, technology, learning and access to build prototype and products aligned with what industries requires; and should be supported.

She shared that the capability centres in Saudi Arabia have an innovation centre for learning 4.0. The innovation centre for learning creates jobs and has a small-medium enterprise accelerator. The small-medium enterprise accelerator has a freelance portal, which empowers women enabling them to work from anywhere using digital skills. There is a placement portal; where people wanting to go into formal employment can match up skills with supply and demand.

Another area of interest is the co-production hub, which consists of a core team which creates digital and blended content for the kingdom primarily in Arabic. The Innovation Centre for Learning has been reworked in South Africa into a digital skills hub, which runs learnerships, aligned to qualifications, supported through partnerships with private sector, for the benefit of the public sector.

Saudi Arabia has established a learning ecosystem, a system where physical and digital assets come together. She noted it's important to set these up, as the physical environment in which people learn will never go away. The tools used to learn will be introduced into those physical learning environments, and the physical and the digital will blend. However, what is important is the construction and design or use of technology from a learning perspective as this will become more immersive to understand the possibility of virtual reality.

Saudi Arabia has the financial means to use advanced technology in learning for example; but this is not the case in South Africa; however, technology is becoming more accessible. Technology is evolving at an unprecedented pace. With this in mind, there is a need to keep an open mind on where learnings can be taken and must view technology as an enabler. There is a need to create meaningful content and learning experiences with learning outcomes.

Ms Chadwick noted the following recommendations:

- Education must work together with technology to build a skills pool within the 4IR framework.
- There is a need to break down silos.
- Get small-medium enterprises involved in innovative programmes.
- Provide the necessary support to small-medium enterprises as they are failing.
- Embrace the e-tech community in their ecosystem.

- Create an impact fund for e-tech entrepreneurs; as these businesses need that kind of ecosystem. They have great ideas, but they do not have access to capital and procuring from government is also difficult.
- Design something that looks different, something for a new sector.

Speaking about the skills needed for the future, Ms Chadwick noted that, they do not know what skills will be required in five years' time as the currency of skills is between two and a half to five years. Therefore, there is a need for industry to get involved. Corporates need to work together with SETAs and begin to provide SETAs with information on critical skills, and the skills required in five-years-time for instances. She shared that TTRO is currently in the process of building a skills exchange app.

In closing, Ms Chadwick emphasised the need to leverage technology in a more powerful way to enable one to get to where they want to get in preparing learners for the skills of the future; and apply their minds and be more innovative with technology for education.

6.3. Discussion

Questions	Answers
<p>Q1: DHET: The biggest component of your presentation centred around automation, in terms of examining the implications of 4IR to jobs and skills; given that 4 IR is basically a fusion of different technological advances, of which automation is one; would it be correct to say the substantial implication of 4IR will be ascribed to automation vis-à-vis the other technologies like machine learning, artificial intelligence and so forth?</p> <p>The other question relates to the use of digital skills in education and training, specifically reference to big data? Whose responsibility is it to focus on the design of a curriculum that will address the current and expected future skills needs; and determine the best approach to apply given the time lags that are there between the curriculum design in terms of trying to respond to the changes in the skills needs in the labour market. In addition, what are other alternative approaches that can be considered for this?</p>	<p>A1: Dr Marieke Vandeweyer: Automation is not necessarily one aspect of these technologies; automation is the result of these technologies it's not one part of it. It encompasses different types of technologies.</p> <p>In terms of the big data, this type of information shouldn't be used to immediately change curricular – it should be used to understand where the demand is going to be, to establish what occupations are increasing and which ones are decreasing; and understand the skills employers are looking for.</p> <p>It is interesting to see where the patterns are going and taking this into account in education and in training will be valuable. Education has been quite slow in adapting to changing curricular, when talking about adult learning programmes or the non-formal programmes for example are easier to adapt. Often one can use information quicker to reply to the needs of the labour market.</p>
<p>Q2: JET Education Services: What a pleasure having these kind of quality inputs. Please elaborate more on the South American country you spoke about, and their data bank of skills for the unemployed and how these can be collected in a way that can pronounce employability. The challenge, it seems, is not about the technology, the challenge would be how to articulate formal systems and qualification systems – as it seems that's where there is a barrier. The private sector is very open to these kinds of things but government is very slow in embracing them so it will be interesting to better understand how</p>	<p>A2: Dr Marieke Vandeweyer: In a number of countries, almost 90% of training that people participate in is non-formal. It is not going back to University, it's not going back to a TVET College to obtain an NQF qualification, it is workshops and short programmes where you get certificates. France has one of the best examples of this kind of model of learning. The country has over 100 000 providers of non-formal training; however because it is very difficult to regulate this market there is an increase in certification quality levels for these providers but it is quite a challenging task and a lot of countries struggle with this; and so in such</p>

<p>South Africa something can do like what is being done in South America?</p>	<p>instances, there is a need for quality assurance mechanisms that obviously need to be introduced as well.</p> <p>These certificates are designed together with social partners so that employers know the value of these certificates.</p> <p>Also, these programmes are adaptable to the needs of the employer. These are valued by the labour market even though they don't fit into the NQF.</p>
<p>Q3: UJ: There is tension in terms of what needs to be done with post school education, higher education and what is sometimes expected, what is your view on this? On one hand, it seems there is agreement agree; on the other, it seems impossible to prepare people for work life for the rest of their life even for the next five or ten years. Then there are employers who say universities of higher education must do a better job at preparing people for the skills needed in the market – how successful have these efforts been? What is your view?</p>	<p>A3: Dr Marieke Vandeweyer: The dilemma between preparing someone for work and this entire whole working life is impossible. Education, certainly in universities, needs to ensure that people have good foundational skills, are ready for changes and can apply different types of skills and learn and they can build on that and that is what is important. It is true that you can't adapt every time something changes, there are some general patterns - in most countries there is a big demand for graduates; and people must be convinced to study for certain types of programmes. In South Africa, there is a need to build strong foundational skills and ensure that people have opportunities to participate in lifelong learning courses.</p> <p>In terms of the qualification architecture the qualifications - Germany for example is very famous for its vocational educational system they review their qualifications at a very fast pace, they have initiatives for social partnerships, and quite a number of their qualifications are reviewed every year. So, at times it's not about changing the qualifications structure, but about making small changes to the programmes to ensure that qualifications adapt to the needs of the labour market.</p>
<p>Q5: University of Stellenbosch: What has been the success relating to the take up in technology as well as in education innovation? How is technology being absorbed into society?</p>	<p>A5: Ms Kirsty Chadwick: Some great success stories have come out of Saudi Arabia; with the launch of the Capability Center, there has been an amazing take up by young people – some doing robotics and coding. In South Africa, unless this kind of innovation is localised it would be a challenge to implement; however, if localised, it's something that would work. What's important is to design for where we are and the needs of the country and that will make a difference.</p> <p>Most countries have deployed technology without necessarily thinking about learning;</p>

they pop up technology and give teachers a laptop and kids tablets and expect them to just get with it; that kind of approach to technology is not going to impact change; unless solutions are designed in partnership with government design a whole solution around it and where we've got to now with our partnership with government and all stakeholders involved to make sure that we create genuinely innovative societies.

Breakdown the silos and find the collaboration and that will reduce the tensions and bring people to work together.

7. Session 7: How Can the PSET System Respond to Opportunities Provided by the 4IR? (Panel Discussion)

Facilitator: Ms Gerda Magnus, Chief Director: Programmes and Curriculum Innovation – DHET

This session focused on key aspects of how the PSET system can respond to opportunities provided by the 4IR. It considered inputs from a panel of expert speakers who exchanged views regarding the issue and engaged with delegates in a discussion based on their inputs.

7.1. The Implications of the 4IR for Skills Supply and Demand

Presenter: Prof Haroon Bhorat, Director: Development Policy Research Unit (DPRU) – UCT

Prof Bhorat positioned the 4IR from a research context, providing early results of the impact of the 4IR on the South African labour market, and introducing a fundamentally new way to think about the labour market. His presentation focused on the labour market polarisation in 4IR. He shared some ideas around the consequences for labour supply in terms of 4IR and highlighted that when engaging on 4IR, it's important to note that it is very different from the Third Industrial Revolution. The 4IR has to do with new technologies, and things such as augmented reality, AI, the machine to machine communications, 3D printing, cloud services, the IoT and big data. He noted that within the context of 4IR, robotics is increasingly becoming part of the global economy and data is changing the way that work is analysed.

Prof Bhorat argued that one thing to take note of within the context of 4IR is that things are happening at the top, and the bottom end of the labour market but good things are not happening in the middle of the labour market. There has been a number of changes in the workplace and there are increasing opportunities in high wage occupations that require complex problem-solving abilities or problem-solving capabilities. Jobs in the middle-income distribution are easily automatable; and these jobs are at the highest risk of erosion during 4IR. He highlighted that the effects of technological displacements are heterogeneous and there is a new form of inequality emerging in the labour market.

4IR impact in terms of employment outcomes:

- There is a loss of employment due to automation in the old sectors.
- There is some new level of employment in the new sectors.
- Aggregate employment is increasing in certain economies.
- Blue-collar workers are losing jobs.
- New jobs are being created such as data analysts and coders, in the new sectors.

Prof Borhat noted that 4IR is not only about AI; but soft skills matter too, as employers are looking for soft skills, IT proficiency, a University degree and work experience.

Winners and losers in 4IR?

- The winners are knowledge workers, those at the top end with high levels of social intelligence, and technical abilities.
- The winners are professional, IT programmers and scientists.
- The losers are in medium-skill occupations.
- Blue-collar workers are also in the category of losers as they are easily replaceable.

Prof Borhat emphasised that there is a need for a task-based approach to labour demand where work is no longer about occupation and the change in the distribution of occupations, but how occupations have certain task contents. Within this context, there are two types of tasks, the first routine and non-routine and the second cognitive and manual tasks. Examples of occupations with lots of routine but cognitive components include sales workers and insurance brokers. An engineer or an artist is an example of a non-routine cognitive job; as in this line of work everything is new, and everything is different.

Routine manual work includes construction workers and mechanics and non-routine manual work includes domestic work, waiters and security guards. Jobs or tasks with a high routine component can be automated. He noted that there would be no longer a need for a financial broker or an investment broker for example, as there would be robo-advisers as a lot of the tasks in this field of work are routine.

He highlighted that non-routine jobs are harder to replace with machines and routine jobs are easy to replace with machines. Tasks that are high information content, high routine content, and high face-to-face content, can easily be replaced. An assembler or machine operator are examples of occupations with a high or routine component; as everything they do every day is the same. These types of tasks are replaceable by machines.

Prof Borhat cautioned not to ascribe everything to 4IR revolution, as there is competition from China and Indian programmers are replacing USA programmers because they are much cheaper; and these factors are changing the wage percentages around the world. In South Africa, on the one hand, there are increases at the bottom end, with massive increases for all at the top end; and on the other hand, there are decreases in wages in the middle of the distribution.

He explained the following as the role of 4IR in explaining changes in wage percentages:

- Routine tasks are being replaced; Face-to-face tasks are not.
- Cognitive skills are in demand.
- The collapse of the middle of the distribution of the middle classes in South Africa can be blamed on 4IR.
- There has been a collapse in jobs in the middle distribution.
- Onsite work is replaceable.
- Onsite work can be completed offshore.

Prof Borhat noted that while a number of issues exist around 4IR there is some good news, for example the demand for analytical skills has increased.

In South Africa, 4IR is about protecting workers at the bottom, and increasing demand for highly skilled workers, and workers in the middle losing out; however, the bottom end jobs are minimum wage protected. Of importance to note is that while there has been a replacement in jobs from routine tasks to analytical skills, the people affected are not the same people.

The consequences of 4IR for the labour supply is that core skills tasks require proficiency in maths or statistics and this is an area where a number of challenges remain.

In closing, he noted that 4IR is here to stay; there is no route to which there can be a return. With this in mind, it is important to shift their framework, to think about tasks rather than occupations, and design appropriate policy measures for that.

7.2. What Kind of Skills, Knowledge and Attributes are Needed to Prepare Students for a Digitised World?

Presenter: Ms Dianne Woodward, Solutions Design – Harambee Youth Employment Accelerator

In her presentation, Ms Woodward shared lessons learnt and insights through the work that Harambee has done with its network of over 500 employers. They have an active network of more than 460 000 excluded youth. They have placed more than 150 000 excluded youth into income generating opportunities since 2010 when they started to conceptualise the model.

The organisation has a national presence and engages with a lot of employers, educational institutions, academic partners, to understand particularly how to integrate unemployed youth with no or very little prior working experience into the digital world. To do this some sort of a diagnostic has to be implemented to understand from employers what their expectations are and what they're looking for.

Ms Woodward noted the following key issues:

- There isn't a common language in the marketplace.
- There is low understanding of what businesses require.
- There is no sense of urgency toward the need to build a digital pipeline from the bottom up, to start integrating unemployed youth into this pipeline.
- Default is to recruit graduates for experience.

Ms Woodward noted that work readiness should involve integrating unemployed youth into most formal jobs to ensure they can adapt to the corporate environment and have a basic understanding of what business and the job is about, and about the basic discipline, i.e. time keeping, attendance, punctuality and the right attitude.

Current environment employers require students to:

- Be able to work in cross functional multi-disciplinary teams.
- Be able to work in agile environments.
- Be able to multitask.
- Have a basic understanding of business acumen.
- Have an understanding of the working world, which is tested using case studies during recruitment to exclude those without experience.
- Have good communication and problem-solving skills.
- Have the right energy and the right attitude.
- Be hungry to learn and want to continue learning.
- Be adaptable, confident and resourceful.

Ms Woodward noted that how students are prepared is important. Communication and ensuring an understanding of English language, fluency, literacy, ability to communicate and numeracy are some of the key elements to consider, as well as digital literacy and fluency.

She noted that at times teaching technical skills and going through formal education will not necessarily get one through the door in employment, as technical skills often tend to be lengthy and

an expensive exercise. However, she argued that there is a need for traditional skilling pathways, Technikons, universities, but also cautioned that these are also lengthy and expensive pathways. If the country is to address the high unemployment rate, there is a need to explore ways in which to do things differently and find innovative ways to close the gap, to provide opportunities for young people to get a foot in the door so that they can be interviewed as the number one priority, be assessed as number two and get the opportunity to gain experience on the job, where the best learning is. That is where the focus should be as unemployed youth transition into these opportunities. She noted that a lot of advocacy and change management is required. She said that data analytics and software development are two of the highest opportunities in role requirements in the digital world; and shared that Harambee designed a shorter pathway on how to prepare unemployed youth into a junior data analytics role after doing diagnostics and code signed with business to make everything responsive and adaptive.

The following challenges were also highlighted:

- Systemic barriers through to accreditation, policies.
- Lack of access to finance, data knowledge and information in terms of how to integrate into the world of work.
- The lack of alignment between higher education and the world of work.

Ms Woodward noted the following recommendations:

- Reposition the eco-skilling ecosystem to integrate more youth into the world of work.
- An agile and inclusive workforce development with less accreditation.
- Better managed pathways for young people.
- Multi-skilling. Harambee has developed a pathway management platform where they are constantly nudging and engaging with the youth because it is a complex landscape out there.
- Rely on demand-led credentialing linked to actual business needs, instead of just relying on qualifications, schooling and what marks were obtained.

In closing, Ms Woodward shared that Harambee is co-financing solutions which are outcomes-based models where people are participating in the skills landscape, where funding is only allocated on the outcomes of certain predefined performances, performance outcomes – whether solving barriers to employment or actually when a young person transitions into employment.

There is a need for a mindset where the focus of the investment is not just on skilling and training but on the result and ability to transition into employment.

7.3. Discussion

Questions	Answers
<p>Q1: DHET: The public sector is now the largest employer in South Africa, where will the 4IR have the biggest impact, specifically in relation to automation of tasks, in the private or public sector?</p>	<p>A1: Prof Bhorat: A third of workers are employed in the public sector, two thirds in the private, but the key thing is that public sector employment has been growing rapidly and it constitutes a disproportionate share of new jobs created since 2000. You don't have what could be considered growth-induced employment generation. Public sector employment creation is not productivity or growth linked. If you remove political economy considerations, the public sector, or parts of it, are ideally positioned for the impact of 4IR. The types of services that are rendered through large parts of the public</p>

	sector, there are certain occupations, there are certain tasks, that can be automated.
Q2: Mining Qualifications Authority (MQA): What are the implications of 4IR on blue collar workers? In the mining sector for example, many of the employees are plant and machine operators who are mostly uneducated, and many of them are being retrenched. What can a 46-year-old person do to access opportunities that come from the 4IR?	A2: Prof Borat: In the mining industry you'll see this across the wage distribution, that there is a hollowing out in the middle of the mining wage distribution. The determinants are not only from 4IR though. A lot of the mines have struggled because of the prices of commodities or because of political economy decisions. If you look at the Commission for Conciliation, Mediation and Arbitration (CCMA) training lay off scheme, it has practically completely collapsed practically and there are hardly any workers coming through it.
Q3: UP: We are all aware of the crisis that we are facing with unemployed youth. Is there really an openness to take these young people into the labour market?	A3: Ms Woodward: When you go into a new job or into a sales and service role, for example - and you're starting to transition unemployed youth into roles that typically were not filled by unemployed youth without prior working experience, it requires a lot of work and a lot of advocacy to shift the market and mindset. When we started in Harambee way back in 2011 and ran our first work readiness program, we were only in partnership with five organisations, four of which were insurance companies, and we were sourcing unemployed youth to place into contact centers. At that stage in those contact centers, the churn was incredibly high and there were vacancies of up to 30%. In a country where our unemployment rate is as high as it is, we shouldn't have entry level jobs with vacancies of up to 30%. There was the mismatch between demand and supply. We had to work a long and hard journey for two to three years to bring on additional employers who would take young people without prior work experience. A3: Prof Borat: The implications for higher education are phenomenal. It's early days but I think it's a lot to do with curriculum design. The modularization of degrees if you like. You can get a degree in the commerce faculty where you do one accounting course, five years of statistics and three years of mathematics. That's a big data analytics degree. You don't really come out with an occupation, but you come out with very specific skill sets. We need to compare pure occupations and task-based ones that are not really an occupation, as it were.
Q4: DHET: What happens to that category of people currently employed who will be displaced by 4IR?	A4: Ms Woodward: A lot of organisations are realising that they have to upskill and reskill their own employees before they start building an

	entry level pipeline. So, it does affect how many youths gain access into the market because employers are naturally going to focus on the reskilling and the upskilling process first. Yet on the other side, many employers recognise that it's a lot easier to bring in a fresh young agile person where you don't have to undo the way of work of the past. You can bring someone in and teach them from scratch.
Q5: Orbit TVET College: Does Harambee have a manual or documents that you can share with institutions on the points that you have raised?	A5: Ms Woodward: Absolutely, from the first day we set up Harambee, we invested a significant amount in an internal knowledge and research department not only that, we partner with research organisations and universities, working in partnership to constantly learn and document what the findings are. So, we do document everything from a digitisation perspective; and we also have a lot of work to do. We are still documenting some of our work and when we have something worthwhile to distribute, we will certainly share.
Q6: Stellenbosch University: Unemployment has been missing from these discussions. Where does it fit? Could you clarify what the difference is between the task-based approach and the whole-qualification approach? How do you explain the relatively high absorption of the low skill? Isn't there a risk that they will eventually be made redundant as well? Finally, with the middle skills, we are talking about retraining and so on, how do those workers move up into the higher ranks.	A6: Prof Bhorat: The unskilled worker is at the bottom end of the distribution and is being protected by minimum wages and they will be protected in the aggregate. But also there's a little bit of action in terms of 4IR because given the current state of technology and given the price of that technology, those workers at the bottom end are somewhat protected – the domestic work, as an example in particular, or security guards, they are protected as their type of is very hard to replace by current technology and or is very expensive.
Q7: DHET: Reference was made to relating to the absence of a common language in the labour market relating to roles and responsibility and tasks, are you aware of the South Africa system for the classification of occupations that is used by STATS SA and also by the other classification systems on occupations which is called the Organising Framework for Occupations (OFO)?	A7: Ms Woodward: We absolutely recognise classifications and the OFO and see it in terms of our language and I think the point that I was trying to say is, in the market place, the ability to put into standard language for entry level roles and what we are looking for is not consistent.

8. Session 8: Can 4IR Technologies Improve Employability? (Panel Engagement with Audience)

Chairperson: Prof Mokong Mapadimeng, Research Director: Education and Skills Development – Human Sciences Research Council (HSRC)

This session focused on key aspects on whether 4IR technologies can improve employability. It considered inputs from a panel of expert speakers who exchanged views regarding the issue, based on a set of questions asked by the chairperson of the session.

Prof Mapadimeng started the panel discussion by noting that he realised 4IR is an ongoing issue which is gaining currency and being led by the business sector. He noted that he also recognised that there is a lot of confusion and disagreement around 4IR and questions around engagement with 4IR, the changes, if any, required to adapt, the epochal changes that should be considered in the world and ways in which to respond to it as it is being preached and popularised by Klaus Schwab for example. Furthermore, who sets the agenda on 4IR, what's driving machine learning and what is the motive behind it.

To the panel he posed the following questions:

- The robots are here, what does this really mean?
- What does it imply in relation to the nature of technologies which are being invested in and the economy?
- What does this mean for the old globalisation debate and for the old debates before about the world is collapsing into the global village?
- What motivates or drives this idea of the AI or robotics phenomenon?
- Is it just an efficiency, or is it driven by the need to cut labour costs or to reduce the power of the trade unions?
- How safe are the new jobs being talked about, how secure are those jobs?

The panellists responded as follows:

Prof Shireen Motala, Professor: Faculty OF Education; and Senior Director: Research and Innovation, Postgraduate School – UJ

Prof Motala noted that universities in Africa and globally are required to contribute to the advancement and development of their societies; this has to be underpinned by teaching and learning strategies that create well educated socially conscious citizens, equipped with skills for the 4IR; this has had important implications for their universities, what is taught, what is researched, contribution to the economy, employment and society.

She continued that there is need to leverage and reposition their universities to optimise their role in reconstructing South Africa's future and development and employment landscape. There is also a need to shift how lecturers teach and students learn. Considerations must be made to understand what's blurring the lines between physical, digital and technological mean for social relationships and for student learning, and whether learning in an environment with peers virtually or in class, better than learning online. Societies must create the spaces for conversations.

Economic competitive, inter-competitiveness and most economically beneficial technological innovations can be traced directly or indirectly back to universities through the retaining of highly and relevantly skilled individuals and through knowledge production and research. The issue of knowledge is really important.

The most sought after 4IR skills are those with high employment prospects; and these essentially include some aspects of the arts and mathematics. Qualifications such as data science and data informatics are increasingly in demands and new technologies and digital platforms make it possible to generate huge amounts of data and changing the way in which knowledge is produced, accessed and used.

There is a need to think about knowledge and skills, big data and cloud computing, machine learning, and get to better understand why many jobs are automatable. What is also really important is that certain highly skilled jobs such as legal research, financial analysis are also prone to automation and more needs to be done to look into this.

Youth unemployment is staggering. In the last quarter of last year, it stood at 54.7% and in the first quarter it was 55.2%. There is a tremendous responsibility on their education system to prepare school

leavers with a future-ready curriculum that speaks increasingly to a technologically driven economically and learners require proficiency in science, technology, engineering, maths and digital literacy.

There are huge benefits in terms of 4IR and new technologies, but there are huge risks in terms of how it can disrupt the labour market and machines become capable of doing new jobs.

Prof Motala concluded that the challenge for universities remains how to get students to invent, create, discover and explore their role in contributing to future-focused, transformative society. This is best captured by a quote by Joseph Aoun who said: "A robot-proof education is not concerned solely with topping up students' mind with high octane facts, rather it must calibrate them with a creative mind-set and a mental elasticity to invent, discover or create something valuable to society. "The question is, how to get from the current position to the desired position?"

Dr Adriana Marais, Founder – Proudly Human; Director – Foundation for Space Development; Faculty – Singularity University and DHET 4IR Ministerial Task Team Member (also aspiring Extra-terrestrial)

Dr Marais indicated that the 4IR is a collection of technologies, it is just a classification for a group of newly emerged and emerging technologies. It is about what this collection of tools can do to help with employability. It is baffling that there is unemployability or unemployment when there is so much to do. How can the tools of newly emerging technologies be used to solve challenges in their society that can make people's lives better?

There is the question on, "How can the 4IR be Africanised or South Africanised, what does it mean for Africa and for South Africa? It is quite simple in the end. It means how these newly emerging tools can be applied to improve the lives of people living in the country. Employability will come naturally from that.

From my activities in space, there are certain aspects of what is called life support in space that citizens in the country do not have access to. There are South Africans who do not have access to electricity, running water in their homes, clean air, nutritious food, or access to data perhaps because of their location. All these can collectively be group as life support resources, because data can enable medical treatment and data can enable education. Power, clean air, water, nutritious food, communications capabilities data and perhaps health care can be included as life support resources.

The current challenge is that 4IR is here, and there is a lack of understanding of how to apply these newly emerging technologies to solve problems being faced by communities; while at the same time inspiring young people that the future can be a place of hope. There is a need to explore ways in which to couple knowledge of emerging technologies with solving these solutions with some inspiration.

There is a need to closely examine ways in which to leverage 4IR technologies. There are companies operating solar exchange out of Cape Town, using block chain to use solar power where they are leasing and selling solar panels in schools, in hospitals and different environments around the Western Cape and South Africa using Bitcoin; this is an example of power coupled with varying variety of 4IR technologies.

There are urban farming tours in central Johannesburg looking at precision farming, growing food in either basements of rooftops, using machine learning perhaps to create ideal lighting conditions exact water amounts, 95% less water is required for these systems to feed the people living in the cities. More than half of the country's population is living in cities, yet there are less and less people doing agriculture. The question is, how are people going to be fed? 4IR can solve these problems and people can get excited about being able to provide food where they live.

The DUT has a programme using cutting edge technologies like printing of membranes and automation in terms of analysing water. There are plenty of activities using cutting edge technologies and at the same time solving those fundamental challenges that many of the citizens face.

Dr Marais surmised that space has been an ideal way to get young people, whether school children or students or emerging professionals, to get excited about the future world. That might sound futuristic or foreign beyond the kind of challenges they are dealing with. However, the challenges remain the same, whether in a refugee camp, an informal settlement, living in an area affected by climate change, living on the moon, or on Mars, human requirements are the same, power water, air, food, communication systems and if capabilities can be coupled in doing this efficiently, through the most recent, emerging, cutting edge technologies, then there can be a solution that can work to solve challenges both on Earth and beyond, for a better and proudly human future.

Mr Bhabhali Ka Maphikela Nhlapo, Education and Training Secretary – Congress of South African Trade Unions (COSATU)

Mr Nhlapo noted that the First Industrial Revolution was about the steam engine. South Africa has a greater problem of public transport, so even before talks about the 4IR, there are concerns about problems of the First Industrial Revolution.

The Second Industrial Revolution was about electricity and there isn't massive electricity in the rural areas.

The Third Industrial Revolution was computers and still there is no data or bulk data provision.

The 4IR is basically a dominant discourse of the WEF as it reflects a crisis of democracy, bearing in mind that it's not possible to have democracy unless all stakeholders are at play.

The deficiency of this discussion of the 4IR is such that there is a conversation among the elites and the rest of the society is not part of the conversation. There has been fewer conversations with communities, with trade unions, but more conversations with universities, employers, even labour brokers and that is the essence of the problem.

South Africa, around 1990, had a manufacturing base of around 27 - 28%. Since then, manufacturing has declined to about 13%. In conversations about 4IR, don't forget that if South Africa had to get there, South Africans would be the losers as the country produces absolutely nothing. The experience of 4IR has been that it has only resulted in retrenchments and more retrenchments; Arcelor Mittal is a good case study. In the 1980s, Arcelor Mittal had close to 60 000 workers at five plants. The company unbundled. Arcelor Mittal currently has less than 10 000 workers because of the Third Industrial Revolution, because of computer-based production which has dislodged 50 000 jobs.

Economist, Adam Smith, talks about markets, and 4IR talks about robotics and computers and the reduction of the human being. One of the problems for capital is who is going to buy the products because the people who are going to buy the products are being dislodged by 4IR? Those are the conversations to explore.

Mr Nhlapo concluded that in an ideal world, labour would be welcoming 4IR because it means workers have enough time to be at home, sitting with their families and doing what they should be doing with their families and robots taking over the production, but in this case, 4IR is making workers unemployed. As a result, workers are negating 4IR.

Mr Louis van Huyssteen, Training Director – Retail Motor Industry Organisation; and DHET 4IR Ministerial Task Team Member

Mr van Huyssteen shared that, the previous day Automechanika had a skills summit; it was called 4IR. It was an inclusive summit with participants including; government departments NAMB, QCTO, SETAs basic education, universities and industry participated. Panellists were moved amongst the delegates in a speed session, so that everyone has an opportunity to talk. It was agreed that an inclusive working group will be formed. It will encapsulate SETAs, NAMB, QCTO universities, basic education and then obviously industry. One of the actions that emerged from the 4IR conference was the need to integrated technological solutions for example for e-learning, e-assessments to meet the requirement of SETAs, QCTO, NAMB and the rest of the requirements of authorities and the departments within this highly regulated skills ecosystem, so that any skills development that happens in South Africa, has currency.

He continued that skills need to have a currency. At dealership level, the sales executive course does not have unit standards or credits. If an individual moves to a position at another dealership they have to redo the sales executive course. They will redo the generics again and learn about the brand; and this is costing employers a fortune; it is repetitive, and the generic stays the same.

He concluded that the industry needs a generic accredited programme on sales executive training. Brands can train their sales people on the brand side.

7.4. Discussion

Questions	Answers
<p>Q1: VUT: Many students coming into the higher education sector are struggling with mathematics and physical science and both subjects have critical skills that are required to support them in the journey of succeeding in articulating to successful degree completion. The pass rate for mathematics and the move from mathematics to mathematics literacy, presents a challenge. Will they have the right analytical skills to be able to comprehend and be able to adjust to the learning platforms that are presented as far as technology is concerned?</p>	<p>A1: Dr Marais: Start at kindergarten or Grade 1. In terms of preparation, its numeracy, logic and problem solving. Programmes such as the Centre for Science Access at University of KwaZulu Natal (UKZN) need to be scaled up. Unfortunately, funding is decreasing, but student numbers are increasing. More funding needs to be put into these programmes. We need to engage with Makers Collectives, who have been using 4IR technology since before these were called 4IR technologies.</p>
<p>Q2: Port Elizabeth TVET College: What are the four or five things that we should do in our own institutions to narrow the gap between the current reality and what needs to be done for the next few years?</p>	<p>A2: Prof Motala: Between Early Childhood Development (ECD) and schooling, between university and the workplace we need a much closer synergy to make the system work more efficiently. The challenge is to level the playing fields, to ensure that all students have proper access to problem solving skills and creative thinking skills. The big issue is infrastructure. We have extremely poor infrastructure in South Africa. The political solutions and the infrastructure solutions all need to work together for us to ensure that our students and our workforces are properly equipped.</p>
<p>Q3: Where do you strike a balance as a union in terms of retaining the jobs that we have and incorporating and welcoming all the developments brought by the 4IR? If we resist,</p>	<p>A3: Mr Nhlapo: We do not have powers to stop companies from coming to our shores, nor do we have power to stop foreign direct investment. Companies are more interested in</p>

we are fighting an invincible, international demands will pile up on us and we have to meet the demands and match international standards. Similarly, when we plan for our education or further develop our curriculum and programmes, we try to match international standards so that our graduates can equally be competent to find jobs and compete for jobs in any country around the world. Where do we strike the balance?

the security of electricity than our views on the 4IR.

We should not be fixated on the 4IR when we have not fixed the problems of the first, second and third industrial revolution. The department of higher education talks about a skills revolution. A skills revolution does not occur as a result of a 1% skills levy, neither does it happen when the public sector is exempt from the levy. It does not take three to four years to prepare a student; it takes seven to nine years. The policy framework is scaring off investors, not COSATU's views.

A3: Mr van Huyssteen: We need to catch up and catch up quickly. We must be cautious that we are not reinventing the wheel. We need to start preparing our lecturers ahead of the qualifications that are going to be required. Yesterday someone mentioned another example, picture a development happens but it happens fragmented and there's no alignment for capturing the continuous professional development.

Q4: UWC: We have developed a model for work readiness for BCom graduates. We have engaged with industry, stakeholders, the private sector, and SETAs; there is a missing link and it is the unions. How can unions play a role in assisting us in preparing the students, the learners for the world of work?

A4: Mr Nhlapo: We need to involve work-based learning programmes in a number of sectors including the finance, banking and insurance sector. Universities can have conversations directly with us or our affiliated union, South African Society of Bank Officials (SASBO). We need to be careful. Once we talk about training at the workplace, that we do not create animosity between those already on the shop floor and the young workers coming in. SETAs are prioritising unemployed young workers. The grant system is structured such that when companies take up young unemployed workers they are paid more in terms of rebates and income tax rebates; this needs to be tweaked. How do you address the broader problem of inequality? We need to address the problems of the first, the second and the third revolution first. If you compare us with the north, Europe, Asia, Japan and China, we will be the losers in the 4IR because we are not producers of technology. We need to increase our spend in education and training. We need to ensure there is an increase in manufacturing to GDP. The bulk of our economy should be manufacturing-oriented. If I can quote Samir Amin: "the choice is between ending the crisis of capitalism and ending capitalism itself" and I think that is the choice we need to make.

Comments

C1: Prof Mapadimeng: The 4IR or the X Revolution is not a destination, but a useful change in how the world works. The outcome could be very significant. At some point we will go to the NDP, which is our country's strategy to be competitive. It is a development strategy for higher education and training, incorporating how the world is changing. We are not doing that yet. We are not ready for that. Now we are having divergent conversations. We need more of these to get the picture and hopefully that will not be a very difficult picture for the unions to appreciate.

9. Session 9: Report Back and Way Forward

Chairperson: Mr Reineth Mgiba, Acting Chief Director: Polity Management and System Planning – DHET

Mr Reineth Mgiba introduced the last session of the Colloquium before calling each of the rapporteurs to summarise the discussions in their Commissions, which took place the day before.

9.1 Commission Report Backs

9.1.1. Breakaway Commission A

Ms Renay Pillay, Director of Policy, Research and Evaluation provided the report back on behalf of Ms Khuluvhe, the commission facilitator for Breakaway Commission *A on Skills Supply and Demand in the Context of the 4IR*.

In summarising the first presentation by Mr Thabang Motsoeneng on Balancing Skills Supply and Demand: A MICT SETA Perspective, Ms Pillay noted the following:

The MICT SETA conducted a study on skills supply and demand based on five sub-sectors (advertising, electronics, ICT, film and electronics media, and telecommunication). The study showed the following:

- Advertising: Multimedia Designer occupations difficult to fill – Lack of experienced candidates, technological change and new work practices.
- Film and Electronic Media: Scarcity of occupations in technical roles – Corporate Communication Manager, Film and Video Editor.
- Electronics: Scarcity in computer and electronics related occupations – Electronics Engineer
- ICT: Scarcity in ICT sector technical roles – Software Developer; Programmers and ICT Security Specialist; Computer Network Technician and Telecommunications Network Engineer.
- On the supply side, of the 40 qualifications in MICT, only 18 registered new students in 2018.
- The study also revealed that with the emergence of the 4IR, there has been an increase in enrolments in SET and skills, and short learning programmes have been identified as a solution to the demand problem.
- Furthermore, the study shows that skills and short programmes are seen as immediate solutions to the demand.

Giving a summary of the presentation on the implications of the 4IR for skills, supply and demand, Ms Pillay noted that the presentation from Prof Paul highlighted that the Third Industrial Revolution ended in 2010; and Industry 4.0 was introduced in 2011 and referred to smart factories – AI was used in factories. He noted that since then a series of changes have occurred and there has been a fundamental change in work.

Ms Pillay highlighted that during the discussion session the following issues were raised:

- What is offered at TVET Colleges is not in line with what is offered at HEIs.
- The quality of TVET lecturers is very important as it can determine whether they can or cannot deliver to the expectations.

- There is a need to build respect for and credibility of TVET Colleges.
- TVET lecturers need to gain exposure through industry programmes in order to lead more relevant teaching.
- Conduct tracer studies and impact studies to inform skills in high demand and identify skills shortages in order to link with employability.
- DHET wants to understand how the world of work is changing – what skills are needed for livelihoods?
- People must create jobs for themselves rather than relying on big companies.

Ms Pillay concluded with the summary of recommendations as follows:

- There is a need for collaboration between education and industry – Cross-sectoral partnerships and projects in the delivery of learning interventions.
- It is important to recognise skills programmes on the NQF.
- There is a need for programmes supportive of lifelong learning.
- Revitalise and modernise the TVET sector.
- There is a need for the development of a professional teaching workforce with strong technology skills.
- Introduce labs at school level aligned to Industry 4.0 technologies.

9.1.2. Breakaway Commission B

Dr Whitfield Green presented the summary of the breakaway commission on *Using Technologies to improve the PSET*. The following insights were gained from the presentation by Dr James Keevy (JET), and Dr More Manda, (MERSETA) on Digital Interoperability: Moving towards data-driven planning in the post-school education and training system:

- JET aims to develop a platform that enables users to share and use data for decision-making for a more efficient and responsive PSET system. In their presentation they identified the following challenges in the PSET system:
- There is fragmentation of the PSET system. There are systemic challenges and people are working in silos; there are limitations in terms of access to data and limited information sharing.
- Data quality is a challenge, it needs to be clean, accurate and reliable.
- Proliferation of open learning initiatives for lifelong learning are uncoordinated and learners cannot access this information easily.
- Some of these challenges can be resolved, as findings show that there are no policy barriers to building a PSET Cloud.

Speaking about the 4IR as a driver of the PSET Applications Process Technology, Dr Dzingwa from the VUT highlighted the importance of ensuring that while the 4IR unfolds, it is important to bring people along, make sure that everyone is on board and not create inequality.

Ms Carol Dwyer shared some insights from her experiences as the Manager for E-Learning at the False Bay TVET College. In her presentation she highlighted that colleges are at different stages, so it is important not to lump them together when designing solutions for them. Instead there is a need support them, bearing in mind their individual needs. She emphasised the need for all 50 TVET Colleges to begin to work together and stop competing against each other.

Dr Green shared that presentations moved from a broad view of the system to a narrowed down institutional-level view and noted that interoperability requires cooperation, communication and one vision, which is to make the PSET system better.

9.1.3. Breakaway Commission C

Giving a summary from the discussions on *Workplace readiness in the context of the 4IR* Mr Zulu shared that Dr Harlan Cloete and Ms Karabo Moloko spoke about municipal readiness to implement the 4IR. They undertook a study which considered whether municipalities are ready to implement and leverage the 4IR and the dimensions required for reinforcement to ensure successful implementation of digital capability. The study looked at six dimensions/indicators of assessment and these were as follows:

- Dimension 1 - Strategy and Leadership.
- Dimension 2 - Customer Care.
- Dimension 3 - Municipal Culture.
- Dimension 4 – People.
- Dimension 5 – Risk Management.
- Dimension 6 – Change Management.

Dr Karen Dos Reis shared more on exploring how WIL can be used as a catalyst to prepare BCom Degree Students for the 4IR focusing on a case study conducted by the UWC. Among other things, the study shows that “Graduates emerge poorly prepared for the realities of the workforce and often find that companies are not willing to help them build practical experience” (Siebrits, et al., 2015). It also showed that there is a need to prepare students for 4IR. The EMS WIL model can be used to develop the 21 skills that can be used to prepare students for the 4IR.

The presentation by Dr Fabian Nde Fon and Dr Melusi Sibanda on the effects of 4IR on Africanisation as an emerging global trend in higher education, sought to understand the effects of 4IR in an African university and link Africanisation to 4IR. They made a number of suggestions on how to Africanise 4IR including through policy, curriculum, technology and grassroots research, innovation, and ethics around 4IR. On the Effect of 4IR on Tertiary Education, Prof Nelishia Pillay shared the following insights:

- *Automated Tutors* and Teaching Assistants: AI tutoring, personalised feedback.
- *Automated Assessment*: Essay marking, psychometric testing and talent assessment.
- *Educational Data Mining and Learning Analytics*: Predicting student success; predicting learning difficulties and identifying success factors for schools.
- *Designing Learning Environments*: Web-Based Courseware, Digital learning environments; Online course and creating pedagogical agents.

The group noted that there are challenges, opportunities and a lot that still needs to be done and there needs to be a way to assess whether or not the PSET system is enabling for 4IR.

Recommendations were made around mapping technology changes against jobs and skills that are being disrupted and designing and developing programmes and qualifications that integrate workplace-based learning to facilitate employability and entrepreneurship.

9.2. Way Forward

Presenter: Ms Trudi van Wyk, Chief Director: Social Inclusion and Quality – DHET

Following a review of the presentations from the two-day Colloquium and the commission report backs, Ms Trudi Van Wyk extracted the following issues raised as points to focus on, going forward:

- Educational policy:
 - Any effective 4IR education strategy must include consideration of the human condition. New technologies and shifting economic power impact people of all socioeconomic levels, and the threats that exist within a world that is increasingly

interconnected, in a way that fosters intercultural understanding and respect for freedom and human rights.

- Critical dialogue with researchers is necessary.
- Advice from academia, government, industry, and the private sector is required.
- Government:;
 - Government has to take the lead in planning, policy development and creating an enabling environment through legislation regulations, norms, and standards.
 - Leadership needs to be less risk averse especially in this world of disruptive change. Focus on innovation and accepting change are now prerequisite for survival.
 - Although digital higher education and training models can be more affordable compared to other education and training options, higher education and training needs to consider the best ways to reaching underserved populations where education can serve as a strong empowerment and change tool - Using socially-relevant models of co-creation and shared value.
 - Major investment in connectivity and technology is necessary. Connectivity must be seen as a basic human right. Affordability of data and access to broadband is crucial.
 - Effective partnerships, collaboration, integration, alignment and sharing of resources, experiences and expertise are key words for scaling higher education and training efforts, effectively deploy work integrated learning and bringing sustainability.
 - Concerted efforts must be made to address risks, privacy and security.
 - Support start-ups through funding and other forms of support in partnership with other government departments, industry and private sector.
 - Expand internships for work experience.
- DHET Institutions:
 - NPPSET – A well-developed plan for a 4IR form of PSET will ensure that students will graduate into a world that they can help shape.
 - There is a demand for both solid qualifications and modularised qualifications (flexibility and micro-learning).
 - Improve quality and relevance of qualifications, programmes, curricula and learning materials.
 - The hallmark of the 4IR is exponential growth and rapid change, which gives the curriculum an imperative to update content on an unprecedented frequency to match the rapid tempo of scientific and technological advances. A more responsive curriculum places an extremely high premium on changing in pedagogy, teaching and learning methodologies, capacity building, as well as the mandate to develop students who can think and reinvent themselves within the changing world they will graduate into, at the same time avoid the crowded garage effect.
 - Leverage 4IR technologies to improve access, equity, quality, success efficiency and responsiveness of education and training.
 - Promote stronger foundational (literacy, numeracy, digital skills) and transversal skills/Core Tasks/Resourcefulness.
 - The need for leveraging online courses/e-learning to use in residential education for undergraduates and to also give more flexibility and modularity of courses. Combine the strength of traditional higher education and training with the increasing trend of self-directed learning and e-Learning.
 - Universities have a much bigger role to play in shaping future technology by being the testbeds for innovation and educating future generations.
 - The shelf life of any skill has become increasingly short, requiring future workers to continuously update their skills and teach themselves about new technologies and new industries that may not have existed while they were being trained for their initial qualifications. There is a need to facilitate and enable lifelong learning and continuous up skilling and reskilling of all students, DHET staff, lecturers, employers, workers.

- The 4IR poses possibilities for skilling, upskilling and reskilling of the employed and the unemployed.

There is a need to focus on the following key areas:

- Real world applications.
- Skills for the future.
- Dialogue.
- Planning.
- Urgency.
- Collaboration.
- Research.

9.3. Social Media Feedback on Engagement

Presenter: Mr Ntokozo Bhengu, Council on Higher Education (CHE)

On social media, the official hashtag for the conference was #DHETRC19 and social media engagement results are as follows:

- 213 posts about the conference were uploaded on social media pages with the hashtag #DHETRC19.
- 41 users who uploaded information were present at the conference.
- 311 people engaged with the posts, more people than the number of people who had attended the conference.
- 73 389 were reached – This is the number of unique users who saw the post containing the hashtag and the key words.
- 18% of the people showed positive sentiments, 80% neutral and 2% showed negative sentiments towards the colloquium discussions.
- 47% of participants were male and 53% female.
- 44% of users were Android users, 33% were desktop users and 16% iPhone users and 6% used other devices.
- All users where in South Africa with one user in Canada.

Top Posts

These are the organisations who engaged with the conference content throughout the colloquium, and they are:

1. CHE.
2. BANKSETA.
3. DHET.
4. Umalusi.

The following social media accounts were the most influential users:

1. Higher education.
2. JET Education Services.
3. BANKSETA.
4. CHIETA.
5. CHE.
6. EWSETA.
7. Umalusi.
8. Dr Colin Thakur, DUT.
9. LGSETA.

Buzz words

The following words stood out on search conversations around the Colloquium on social media channels:

- Research.
- 4IR.
- Education.
- Training.
- DHET.
- Revolution.
- Implications.

9.4. Vote of Thanks

Presenter: Rakal Govender, Deputy Director: Policy, Research and Evaluation: DHET

Delivering the vote of thanks, Ms Govender thanked all the programme directors, chairpersons, presenters, facilitators, scribes and delegates, before she acknowledged the SETAs and sponsors for their contributions.

Ms Govender also expressed her immense gratitude to members from different SETAs, DHET the NQF directorate, communications unit and policy research and evaluation directorate for their hard work in preparing for the Colloquium and contributions during the Colloquium. She concluded by announcing that the 2020 Research Colloquium would be on Open Learning.

Glossary of Terms

Africanisation	The process of defining and interpreting African identity and culture.
Application Programming Interface	An interface or communication protocol between a client and a server intended to simplify the building of client-side software
Automation	The introduction and use of automatic equipment in a manufacturing or other process or facility.
Big data	Extremely large data sets that may be analysed computationally to reveal patterns, trends, and associations, especially relating to human behaviour and interactions.
Blended Learning	A style of education in which students learn via electronic and online media as well as face-to-face teaching.
Blockchain	A system in which a record of transactions made in bitcoin or another cryptocurrency are maintained across several computers that are linked in a peer-to-peer network.
Blockchain Technologies	A time-stamped series of records of data managed by a cluster of computers and secured and bound together using cryptographic technologies.
Cloud	Servers that are accessed over the Internet and the software and databases that run on those servers.
Cloud Computing	The practice of using a network of remote servers hosted on the Internet to store, manage, and process data, rather than a local server or a personal computer.
Critical Skills	Refers to particular capabilities needed within an occupation, for example, general management skills, communication and customer handling skills, teamwork skills, and communication technology skills.
Data ethics	Refers to the responsible and sustainable use of data. It is about doing the right thing for people and society.
Data engineering	The aspect of data science that focuses on practical applications of data collection and analysis.
Data privacy	Also called information privacy, is the aspect of information technology (IT) that deals with the ability an organisation or individual has to determine what data in a computer system can be shared with third parties.
Data protection	The process of safeguarding important information from corruption, compromise or loss. The importance of data protection increases as the amount of data created and stored continues to grow at unprecedented rates.
Distance learning	A form of education where there is little or no face-to-face interaction between students and their instructors. Distance learning students usually study from home, instead of attending physical classes.
E-tech entrepreneurs	Those who solve problems primarily through the development of technology.
Futurologists	People whose specialty or interest is futurology or the attempt to systematically explore predictions and possibilities about the future and how they can emerge from the present.

ICT	Extensional term for information technology that stresses the role of unified communications and the integration of telecommunications and computers to enable users to access, store, transmit and manipulate information.
Industrialisation	The process by which an economy is transformed from primarily agricultural to one based on the manufacturing of goods.
Innovation	A new idea, creative thoughts, new imaginations in form of device or method.
Ledger	The principle book or computer file for recording economic transactions.
Lifelong learning	The ongoing, voluntary and self-motivated pursuit of knowledge for either personal or professional reasons.
Makers Collectives	A non-profit organisation that empowers creative entrepreneurs while cultivating a supportive community around them.
Moore's law	Refers to Moore's perception that the number of transistors on a microchip doubles every two years, though the cost of computers is halved. It states that the speed and capability of computers increases every couple of years, and computers will cost less.
Nano degrees	A course of study which is much shorter than a university course and focuses on the skills needed for a job, especially computer-related skills.
Open data	Content that can be freely shared by anyone for any purpose. After the Internet became accessible to everyone in the mid-1990s, open data became a major theme due to the ease in which information could be disseminated globally.
Open learning	Learning based on independent study or initiative rather than formal classroom instruction.
Open science	Open Science is the practice of science in such a way that others can collaborate and contribute, where research data, lab notes and other research processes are freely available, under terms that enable reuse, redistribution and reproduction of the research and its underlying data and methods.
Quantum Computing	The area of study focused on developing computer technology based on the principles of quantum theory which explains the nature and behaviour of energy and matter on the quantum (atomic and subatomic) level.
Server	A computer or computer program which manages access to a centralised resource or service in a network
Self-based learning	A process in which individuals take the initiative, with or without the help of others, in diagnosing their learning needs, formulating learning goals, identifying human and material resources for learning, choosing and implementing appropriate learning strategies.
Simulation	The approximate imitation of a process or a system.
Taxonomies	The branch of science concerned with classification, especially of organisms; systematics.
T Shaped	The skills and specific attributes desirable in workers. The vertical bar refers to knowledge and experience in a

	particular area while the top of the T refers to an ability to collaborate with experts in other disciplines.
Virtual classrooms	An online learning environment that allows for live interaction between the tutor and the learners as they are participating in learning activities. In other words, the virtual classroom is a shared online space where the learners and the tutor work together simultaneously.
Virtual Reality	The user of computers to simulate an experience that can be similar to or completely different from the real world.

**THE 2019 DHET RESEARCH COLLOQUIUM
PROCEEDING REPORT
IS PROUDLY SPONSORED**

BY:



Transport Education Training Authority

Heart of Skills Innovation