NELSON MANDELA
UNIVERSITY

Communities Engaging in Smart Technology and Industry 4.0

Centre for Community Technologies

Contents

Aiming for **radical advances** in human potential in Africa, for Africa, **by Africa**

"Our work is focused on the development of human potential and wellbeing, particularly in disadvantaged, vulnerable and deep rural communities. Our tool towards achieving this is needs-driven smart technology," says Professor Darelle van Greunen, Director of the Centre for Community Technologies (CCT) at Nelson Mandela University, describing their work. She is recognised as one of a handful of international user experience experts for developing countries, and is affectionately known as "the people's professor".

Situated in the School of Information and Communications Technology, the CCT was established by van Greunen in 2014 to focus on information and communications technology (ICT)

solutions that can play a catalytic role in solving everyday problems for people living in remote, financially stressed and under-serviced communities.

Technology, and more specifically mobile technology, is playing a key and rapidly increasing role in facilitating community-level knowledge, health, connectivity, economic opportunities, access to infrastructure and services, and management of natural resources.

The role of the CCT is to use technology and innovation to contribute to a more prosperous and inclusive society, to accelerate inclusive economic growth, and improve people's everyday lives. The CCT engages with community members, particularly in South African townships and rural areas, to co-design technology solutions for everyday challenges in these communities so that technology becomes an enabler in their lives.

The CCT integrates transdisciplinary research and innovation with community engagement through the development and implementation of apps and other smart technologies that enable the advancement of education, health, rural and social development, particularly in low income communities. This is combined with training, networking and policy analysis and advice.

The CCT, which is part of the Faculty of Engineering, the Built Environment and Information Technology (EBEIT), is the only research unit at a South African university that specifically focuses on ICT solutions for Africa, by Africans, in Africa.

Since 2014 the CCT has grown into an internationally recognised, multiple award-winning research and engagement entity with an agile team of 19 postgraduates, lecturers, a full-time business analyst and project manager. In addition, the CCT externally subcontracts a team of 12 Mandela University IT graduates now working as IT professionals in Port Elizabeth, which is fast gaining momentum as a software development hub.

Millennium Development Goals

The overarching goal of the CCT's work is to contribute to the achievement of several Millennium Development Goals for South Africa and the continent; namely to eradicate extreme poverty and hunger, achieve universal primary education, promote gender equality and empower women, reduce child mortality, improve maternal health, combat HIV/AIDS, tuberculosis, diabetes and other diseases, and develop global partnerships for development.

Transdisciplinary – community enabler – rural development – technology access – engaged research – human development … these phrases sum up the work of the Centre for Community Technologies (CCT)

Industry 4.0

The CCT is leveraging the opportunities of Industry 4.0 – or the fourth industrial revolution – to include all communities in its benefits. These include technological advancements that can transform South Africa's workforce and skill the nation for a digital economy. Jobs in all sectors can be created by automation. Therefore, creating the right skills for Industry 4.0 becomes critical, as it will change the way industries such as agriculture, healthcare and manufacturing do business.

The biggest tech trend in Africa, and the one that is making the greatest impact on the everyday lives of people is the use of smartphones, mobile apps and the fourth industrial revolution. Africa has seen the fastest uptake of mobile devices in the world and mobile subscribers are set to pass the half a billion mark in the next few years. The digital economy is the giant leap that African economies need to make to advance themselves, and the door is wide open right now for all ICT-enabled young entrepreneurs in the services sector.

The CCT's approach is that that the continent must not just be a consumer of fourth industrial revolution technologies; we must actively participate in the value chain.

This presents the CCT team with innumerable research and innovation opportunities that lead to impactful engagements with communities and our local and international research partners.

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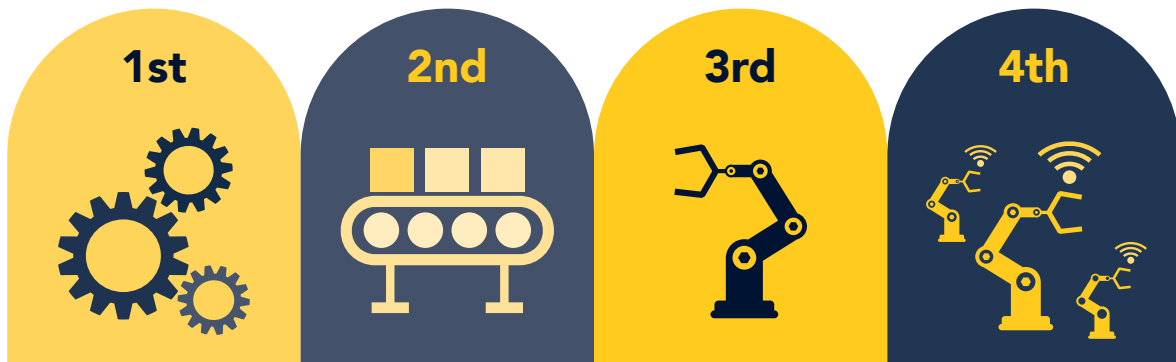
National and Global Partnerships

The CCT's innovative approaches to a wide range of projects in the Eastern Cape, South Africa and several other African countries have attracted global partnerships, including Glasgow Caledonian University, funding from global organisations, such as the European Union, Novartis Foundation and the United Nations Children's Fund (UNICEF), and funding from national organisations such as the Discovery Foundation and the Technology Innovation Agency.

Currently, the CCT has several international projects, of which three are funded by the European Union, three national projects, which are funded by the Department of Science and Technology, the Department of Health and the Department of

Education, and several community engagement projects, as well as a number of pending international grant applications.

Smart solutions

Since the establishment of the CCT, the team has designed and implemented numerous smart solutions for poverty, education and health problems using rigorous evaluation and co-design methods. The team has mobilised decision makers to use the evidence from their research projects not only to influence policy but also to improve opportunities for all people. The CCT focuses on the areas of agriculture, education, health, financial inclusion, traditional leadership, small and medium enterprises, and youth development. Its work extends to several African countries, in partnership with African and international institutions.

"We spend a great deal of time speaking to people in national government in order to align what we do with national and continental priorities," says Prof van Greunen. "What we do in South Africa must be transportable to our neighbouring countries and throughout Africa, where we collaborate with numerous partners."

The CCT – how it
all started

In 1990 the CCT's founder and director Professor Darelle van Greunen realised that if learning was to be part of the democratic journey, it needed to head down the ICT route At the time she was a teacher at Ithembelihle Comprehensive School in New Brighton, Port Elizabeth, where she started the school's first computer literacy classes, school newspaper and drama group.

Multilingual, she speaks English, isiXhosa, Sesotho, Afrikaans and German, and majored in languages, followed by a Higher Diploma in Education at the former University of Port Elizabeth, now Nelson Mandela University.

Recognising the need for ICT skills, she subsequently pursued postgraduate degrees in computer-aided learning, distance learning and usability, and joined the university as a full-time staff member, where she established the CCT.

"Our research requires a comprehensive understanding of the technical knowledge, infrastructure and socio-economic landscape of the communities we partner, to ensure that whatever technology solution is to be developed, it addresses the needs and context of the users," she explains.

Why is there a need for the **CCT**?

South Africa is one of the most technologically advanced countries in Africa. It has made enormous progress in mobile software, security software and electronic banking services. A large number of international tech and social networking companies operate in South Africa, often through subsidiaries, including: Amazon, IBM, Microsoft, Facebook, LinkedIn, Intel, Dell, Novell, and Apple. There are also numerous South African tech companies that sell ICT products locally and to other African markets.

South Africa has great potential to lead Africa in Industry 4.0, also known as the fourth industrial revolution (4IR). However, corporate, government and educational institutions need to collaborate to upskill the nation for the digital economy.

There is a general fear that automation, robotics, artificial intelligence (AI) and machine learning have the potential to widen the gap between income groups, but the requisite skills can ensure the digital divide between emerging and developed markets is bridged. It is therefore necessary to unlock the potential of African youth through projects such as the CCT's *Learn2Code*, which will not only augment innovations but stimulate the interest in using AI to make jobs safer and more efficient.

The South African education system currently does not actively promote ICT and innovation at a young age, and a key subject that can address this, Computer Science, is often largely neglected, even though ICT skills are highly and increasingly sought after in the job market. South Africa is therefore faced with a situation where there is a mismatch between the employment opportunities available and the skills that our students possess.

In response, the CCT has developed its *Learn2Code* programme, which brings coding to learners in a fun and immersive manner. It has the capacity to do more for education in South Africa than any other single movement, given that the effective learning environment of the 21st century is based on access to information technology and the efficiencies in learning it brings.

The aim of the CCT is to:

- Promote radical development of human potential through the use of technology.
- Promote policy interventions aimed at lowering the market costs of technologies.
- Develop best practice strategies in collaboration with communities.
- Demonstrate effective ways of harnessing technology for financially stressed township and rural communities.
- Promote the use of Open Source technologies for addressing public health, education and social development needs.
- Develop strategic partnerships aimed at promoting equality, reducing poverty, and fostering job creation and entrepreneurship.
- Build a better understanding of how innovations in science and technology can enhance the living and working conditions of vulnerable groups in society.

About Nelson Mandela University

NELSON MANDELA
UNIVERSITY

On 20 July 2017, Nelson Mandela University was officially renamed: the only university in the world to carry the name of global icon Nelson Rolihlahla Mandela.

With this name we will be honouring Nelson Mandela by leading our university boldly into the future in service to society.

Our Vision

To be a dynamic African university, recognised for its leadership in generating cutting-edge knowledge for a sustainable future.

Our Mission

To offer a diverse range of life-changing educational experiences for a better world.

To achieve our vision and mission, we will ensure that:
- Our values inform and define our institutional ethos and distinctive educational purpose and philosophy.
- We are committed to promoting equity of access and opportunities so as to give students the best chance of success in their pursuit of lifelong learning and diverse educational goals.
- We provide a vibrant, stimulating and richly diverse environment that enables staff and students to reach their full potential.
- We develop graduates and diplomates to be responsible global citizens capable of critical reasoning, innovation, and adaptability.
- We create and sustain an environment that encourages and supports a vibrant research, scholarship and innovation culture.
- We engage in mutually beneficial partnerships locally, nationally and globally to enhance social, economic, and ecological sustainability.

Our Values

- Diversity
- Excellence
- Ubuntu
- Social justice and equality
- Integrity
- Environmental stewardship

The **change-makers** of the CCT

The CCT Team

The CCT's team are change-makers with diverse skills, qualifications and experience. So much is achieved by the CCT because of its multi-talented team and its powerful spirit. The moment you enter the entre you feel the team's commitment, mirth, creativity, healthy competition and excellence. It's a good place to be.

Director: Professor Darelle van Greunen

Director of the Centre for Community Technologies
PhD Computer Science, MA, HDE, FDE, PMIITPSA, MICSIT
Professor of IT
Honorary Professor, Amity University, India
Fellow of the Discovery Foundation

Prof Darelle van Greunen is from Port Elizabeth in the Eastern Cape. She has a PhD in Computer Science and her thesis focused on the user experience process in business management tools. While working as one of four global user experience leads for the international technology research unit, SAP Research, in Germany, she recognised the disjunct between ICT tools and how humans respond to them, as well as who has access to them and who does not. She brought this invaluable approach to Nelson Mandela University where she founded the CCT.

"**To be the change you wish to see in the world, do not wait for the moment, create the moment.**" – Prof Darelle van Greunen

Afikile Sikwebu

Afikile Sikwebu is from Mthatha in the Eastern Cape. He leads Educational Technology for Teaching and Learning for the CCT with a main focus of introducing programming to primary school learners in townships and rural areas, and training and equipping volunteers as champions of change in their communities. He has a BTech in Software Development and is currently registered for a master's degree in Information Technology.

Loic Ndame

Loic Ndame is from Cameroon. He is a senior researcher and mobile developer (primarily Android). Loic leads and advises on the technology direction for the different digital solutions in the CCT. He has a master's in Information Technology and a Diploma in IT and Computer Programming, both from Nelson Mandela University. He is currently reading for a PhD under the supervision of Prof Van Greunen.

Dr Kevin Kativu

Dr Kevin Kativu is from Zimbabwe. He is a senior researcher and mobile developer with a PhD in Information Technology – Health Informatics. An experienced ICT professional he has a keen research and academic focus on ICT for Development (ICT4D). His technical expertise includes enterprise networking, software development, web applications, database development, advanced Windows and Linux server administration.

Portia Sibozo

Portia Sibozo is from Whittlesea in the Eastern Cape. She is the CCT's Digital Storytelling Lab Facilitator. She does user testing for apps developed by the CCT, does fieldwork for data collection for CCT projects and produces quick guide references for the apps and end-user training manual updates. She is currently doing her BTech in Communication Networks at Nelson Mandela University and will complete this at the end of 2020.

Grant Jacobs

Grant Jacobs is from the Northern Areas of Port Elizabeth. He is a community ambassador, responsible for community skills development programmes in the different community-based hubs. He has matric and has completed several short-learning programmes at Nelson Mandela University, including eSkills, Law and Leadership.

Zoliswa Piko

Zoliswa (Zoe) uses her visual design skills to design and create digital training materials for use in the respective communities. She has also attended courses in wordless picture books to aid her in creating effective training materials.

Natasha Strauss

Natasha Strauss is from Pretoria, Gauteng. She specialises in multimedia for the CCT, including digital music and video production, recording, editing, arrangement, mixing and mastering. She is also a musician who performs under the name Mizz Strauss. She plays guitar, sings and composes. She studied digital music production and multimedia at the EMENDY Multimedia Technology Institute in Pretoria. She has completed the Apple Mac training workshop at Nelson Mandela University, a course on wordless picture stories and is the CCT facilitator for story circles and the creation of digital stories.

Johan Botha

Johan Botha is from East London in the Eastern Cape. He is the CCT's Senior Project Manager. A professional project and logistics manager, he was formerly with the Donald Woods Foundation before joining the CCT. He thoroughly understands the rural environment and donor funding, and manages all CCT projects from inception to finalisation, as well as the partnerships and contracts with CCT clients. His qualifications include:

- Change Management (Certificate) – PROSCI
- Diploma in Project Management – Damelin Business School
- Diploma in Occupational Health and Safety – NOSA
- Diploma in Policing – UNISA

Alida Veldsman

Alida Veldsman is from Cullinan in Gauteng. She is the CCT's senior researcher and business analyst. She was previously with the CSIR as senior project manager and worked as a change management practitioner for SAP Research Germany. She has a Higher Certificate in ICT User Support Services from Nelson Mandela University and a Cisco certification in IT Essentials. She is a PROSCI certified change management specialist, a certified project manager, an impact assessment specialist as well as SAQA accredited coach, mentor, assessor and moderator.

Gareth Turner

Gareth Turner is from Port Elizabeth in the Eastern Cape. He specialises in user experience, user interface design and usability evaluation. He holds a B Tech Software Development degree from Nelson Mandela University. He is responsible for ensuring that technology solutions developed in the CCT are not only usable but create a positive user experience for end users.

Cleopas Watama

Cleopas Watama is originally from Zimbabwe. He is employed as a researcher and assistant business analyst. He obtained a Bachelor of Business Science (Information Systems Honours) from Rhodes University in 2017 and is currently registered for this master's in Information Technology at Nelson Mandela University.

Software developers

The CCT works with a range of software developers, most of them graduates of Nelson Mandela University, including Port Elizabeth-based start-ups, such as Batsamayi Software Development, created by Nelson Mandela University Computing Sciences and Information Technology graduates. The CCT also works with developers in other geographical locations, including Justin Slabbert in Cape Town and Idan Mantzur in Gaborone, Botswana.

Batsamayi Software Development

Founded by Nelson Mandela University alumnus Cinga Nyangintsimbi, Batsamayi is based in Humewood, Port Elizabeth. "The essence of humanity lies partly in our ability to show compassion," says Cinga. "The CCT shows this compassion by taking on the responsibility to help improve the circumstances of our people on the African continent. It is an honour for Batsamayi Software Development to work with the talented CCT team as we all strive to make Africa a better place for all her children."

Idan Mantzur

"As a computer engineering graduate from Louisiana State University, I care deeply about user-centric product development and strive to embed this in my work for the CCT," says Mantzur.

Justin Slabbert

"Each project I have worked in with the CCT has come with a sense of fulfilment that goes hand in hand with the knowledge that, whether it is helping medical professionals share information to better serve their communities, or helping students access advisors from all over the globe, you know the project makes a difference in the world. This, coupled with tackling some unique problems and the solutions required, has made me a better developer. I thank the CCT for allowing me to be a part of their work."

CCT **Research and Innovation** Themes

Our overarching research and innovation themes can be clustered as:

1. Digital solutions to support healthcare (service delivery, preventive care and management of chronic diseases)
2. Digital social innovation and entrepreneurship
3. Educational technology and digital participation
4. Co-creation and collaboration

1. Digital Solutions to support healthcare (service delivery, preventive care and management of chronic diseases)

In our Digital **Healthcare Solutions theme** we study existing ICTs and design new ones that support health and service delivery in low-income settings by improving supervision and administration, empowering the health workforce and increasing knowledge at the beneficiary level.

Our work currently includes projects touching on electronic health records, health education, clinical decision support and behaviour change support. Working with the entire spectrum of stakeholders directly – including targeted sub-populations such as TB patients, community health workers and facility-based health care workers – allows us to ensure that any new systems designed will strengthen existing healthcare.

Included in the CCT's work is the eSkills accredited short learning programme for community health workers and home-based carers in the urban and rural areas. This equips them with computer skills and to use healthcare apps where, for example, they can take a photo of the patient or the patient's problem area and send it to an urban medical practice where the doctor or specialist diagnoses and advises online. This is an invaluable resource in deep rural areas where many people do not have access to clinics or hospitals.

Our key innovations include:
- Ncediso™ App
- *KaziBantu* Solutions
- School Health Assessment Tool
- DigiTB
- mHealth4Afrika
- Find-My-Mojo
- Catch-ur-Mood
- Cancer App

Ncediso™

The Ncediso™ app is an integrated mobile application developed to upskill community healthcare workers, including nurses and clinic practitioners, in areas where basic healthcare, first aid skills and clinics are scarce. The application allows for the early detection of various disabilities and diseases among children, as well as monitoring child nutrition, management of chronic disease, and providing information on infectious and non-infectious diseases, various other conditions and first aid. This app is unique in the sense that all content is adapted for the South African and African context, and all medications and suggested treatments are aligned with what is available on the African continent. All imagery in the app is contextualised and the app is available for download in the Google Play Store.

Digital health apps available on Google Play Store:

- NcedisoTM
- Find-My-Mojo
- Catch-ur-Mood

KaziBantu Solutions

In isiXhosa, KaziBantu means *Active People KaziBantu's* slogan is "Healthy Schools for Healthy Communities".

The *KaziBantu* project is a collaboration between Nelson Mandela University, the University of Basel in Switzerland, and the Swiss Tropical and Public Health Institute. It was launched in October 2017 with the aim of improving the health and overall well-being of learners and teachers in primary schools in disadvantaged areas of Port Elizabeth. *KaziBantu* is led by Professor Cheryl Walter of the university's Human Movement Science department and Professor Uwe Pühse from the Department of Sport, Exercise and Health at the University of Basel in Switzerland.
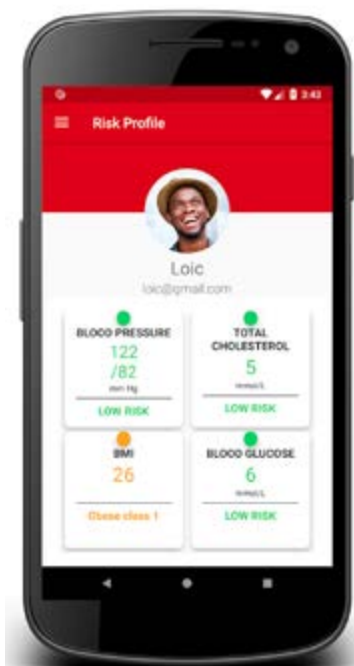
The CCT is responsible for the ICT system and database for all types of computers and mobile devices, and the associated apps for three of the *KaziBantu* programmes, namely *Kazi*Health, *Kazi*CHAT and *Kazi*Kidz.

*Kazi*Health is a Teacher Health Tool app with five components, ranging from a personal health risk profile to lifestyle coaching to personalised goal setting and progress. The intention is to assist teachers to manage their health themselves. All blood pressure, total cholesterol, blood sugar and anthropometric measurements are entered into the *Kazi*Health app, which has in-app tips and tools to manage their health risks. *Kazi*Health is in the public space and can be downloaded from Google Play Store.

*Kazi*CHAT is a Comprehensive Health Assessment Tool (CHAT). It is a web-based system that enables healthcare practitioners or researchers to electronically capture and analyse data collected during teacher health assessment and to generate customised reports. The system was developed by the CCT in collaboration with biokineticists from Nelson Mandela University's Department of Human Movement Science.

The CCT is also contributing the ICT component of the *Kazi*Kidz portal – an educational and instructional tool for primary school teachers, including a range of easy to use programmes with physical fitness games, moving-to-music, and health, hygiene and nutrition education lessons. The aim is to encourage children to lead healthier lives through fun content, games, activities and music.

School Health Assessment Tool

This app is aligned with the Integrated School Health Policy of South Africa. It allows school nurses to create an electronic health profile of each learner. It also includes the World Health Organization standard growth charts. The app is interoperable with systems used by the Department of Basic Education. The digital School Health Assessment Tool highlights health problems in schoolchildren, such as hearing and vision impairment, poor oral health, HIV and AIDS, mental health

issues, such as psychiatric disorders, and risky behaviours, including substance abuse and unsafe sexual practices. The app assists in identifying the many social determinants that negatively affect the health and development of children. Among these are socio-economic issues such as poverty, orphaned children, and child-headed households. It also considers food insecurity and malnutrition, including under- and over-nutrition with their consequences, such as stunting and obesity. The app uses "store and forward technology", which sends data to a central repository when connectivity becomes available, which is essential in South Africa where many of the rural areas do not have connectivity.

DigiTB

The use of technologies in tuberculosis (TB) management is a top health priority for South Africa. At present there are no electronic health records in South Africa's public sector to monitor and manage TB patients. The latest statistics from Stats SA cite TB as number one on the list of the ten top causes of death in South Africa: two is diabetes; three and four are heart diseases; five is HIV/AIDS; and six is hypertensive diseases. The development of DigiTB – a mobile application aimed at reducing the drug-sensitive TB burden in the Nelson Mandela Bay Metro through

each patient, and identify and respond to TB hot spots in the Metro. They are able to focus their attention here to help curb the spread of TB through health interventions and educational and awareness campaigns.

MHealth4Afrika

The €3 million mHealth4Afrika (Maternal Health For Africa) project, led by Professor Darelle van Greunen, is the only European Union-funded Horizon 2020 or H2020 project that was awarded to South Africa out of seven national submissions. It is a collaboration between the CCT and European partner, the International Information Management Corporation (IIMC), with Prof van Greunen as the principal investigator for South Africa and the technical lead of the whole project. It is being used to build a mobile, electronic management system for patient/client data in public clinics and hospitals in Kenya, Malawi and Ethiopia, initially focusing on the records and data for pregnant women and their full pregnancy cycle until the newborn phase.

Find-My-Mojo

The Find-My-Mojo app is a valuable tool developed by the CCT to help individuals to manage their emotions and to improve the lives of those living with mental issues. Whether it's depression, anxiety, stress from work, family, relationships, student life, or other conditions, Find-My-Mojo helps individuals to assess their personal wellness and to seek immediate assistance in the event of a crisis or if they need to talk to someone via the app's quick link to 24/7 support services.

To assist in monitoring moods and anxiety for better management of these, the CCT developed the Catch-ur-Mood app. It enables the user to record and track their mood and activity patterns, empowering them to better understand themselves and manage their mental wellness.

The Find-My-Mojo app was launched on on 2 Dec 2019 at Nelson Mandela University. The Catch-ur-Mood App was launched in Johannesburg, February 2018, at the Movement for Global Mental Health's 5th Global Mental Health Summit. At the launch, Prof van Greunen said that as the prevalence of mental illnesses like depression and anxiety continues to grow, clinicians have increasingly turned to mobile apps as tools for aiding their patients' treatment. She added that these apps can be especially helpful for teenagers and young adults suffering from depression or any form of mental illness. The apps are a useful way of engaging people who may be unwilling or unable to attend face-to-face therapy, or to provide support between therapy sessions. The Find-My-Mojo and Catch-ur-Mood apps are available through Google Play. The CCT is also working with the Movement for Global Mental Health to develop innovative solutions to address global mental wellness issues.

Cancer App

In South Africa, a high percentage of women (especially black women) present with advanced cancer (Stage 3 and Stage 4) when it is usually too late for them to be cured. A 2010 research

more effective management of disease cases – was initially funded by the Discovery Foundation and thereafter by the Technology Innovation Agency, for scaling and roll-out.

The DigiTB app enables community health workers and general healthcare practitioners to record each patient's health data on a cellphone for easy access. The data includes the patient's name, ID, contact details, X-ray reading and sputum results, medications used by the patient, contacts they've had, glucose levels (due to the strong TB–diabetes correlation), and what patients ingest. The biometric recognition supporting Directly Observed Treatment (DOT) on the app ensures adherence to medication. Also part of the project is the use of Video Observed Treatment (VOT) which allows a healthcare professional to connect in real time to observe the patient taking their medication to further ensure compliance.

In addition, GeoID and GeoMapping register the GPS location of patients with drug-susceptible TB in the Nelson Mandela Bay Metro, using the built-in GPS capability of the phone; heat maps are then generated to indicate where these patients are moving around in the community and beyond. With this information, healthcare professionals and healthcare workers can manage

study in Ga-Rankuwa, a township 35 km north of Pretoria in Tshwane, South Africa, revealed that "women's knowledge and understanding of cancer and health-seeking behaviour related to cancer, does not facilitate early detection and therefore the possibility to be cured. The fundamental strategy of primary and secondary prevention of cancer, teaching the community, remains a challenge for both nursing practice and nursing research" (Maree and Wright, 2010).

It is evident from this research, and there is a much more like it, that there is a definite place for the use of mobile technologies to reach women directly, particularly those who live in rural and remote areas in South Africa. Awareness creation, information sharing and education about one of the most prevalent cancers, breast cancer, would benefit these women in early detection and treatment, and to prepare them for the psychological impact of the disease.

The majority of cancer apps are developed in the United States and they do not cater for South Africa's unique diversity, including eleven indigenous languages and different cultural beliefs. For a proof of concept for a South African app, we propose developing

the app for the Eastern Cape province, with isiXhosa and English as the preferred languages. The aim is to strengthen the efforts in the province to beat breast cancer. The CCT's collaborators are leading Eastern Cape oncologists, cancer-focused social workers and leading cancer researchers in South Africa's Medical Research Council.

The cancer app will cover the following themes:

1. Learn about cancer
2. Ask questions and get answers
3. The journey of cancer (a resource guide on managing the illness, asking the right questions of physicians and getting the right professional and personal support).

## 2. Digital Social Innovation and Entrepreneurship

Digital Social Innovation and Entrepreneurship

Digital Social Innovation (DSI) is an emerging field, with little existing knowledge on who the digital social innovators are, which organisations and activities support them and how they use digital tools for social change. The development of open data infrastructure, knowledge co-creation platforms, wireless sensor networks, decentralised social networking, free software and open hardware, can potentially create the conditions to gather knowledge, raise awareness and spur collective actions.

This research theme endeavours to tackle large-scale South African problems. The CCT, together with innovators in civil society, tech and social entrepreneurs, is developing inspiring digital solutions for a variety of social issues in areas such as health, democracy, consumption, money, transparency, and education. The most promising DSI projects combine novel technology trends, such as open data, open hardware, open networks, and open knowledge in new ways to achieve social impact.

The CCT recognises key socio-economic trends with potentially significant impact such as the "collaborative economy" as one of a range of new economic models, based on knowledge commons and sharing of platforms and digital currencies, and "new ways of making", based on the fourth industrial revolution and its advantages. Linked to this is digital entrepreneurship, which opens up new possibilities for prospective entrepreneurs. Some opportunities are more technical, but many others are within reach of anyone who learns the basic skills of digital entrepreneurship. These basic skills include prototyping new business ideas, finding new customers online, and improving business ideas based on data.

Beyond learning new practical skills, digital entrepreneurship is also about new theories and new ways of thinking about entrepreneurship. In terms of education, digital entrepreneurship
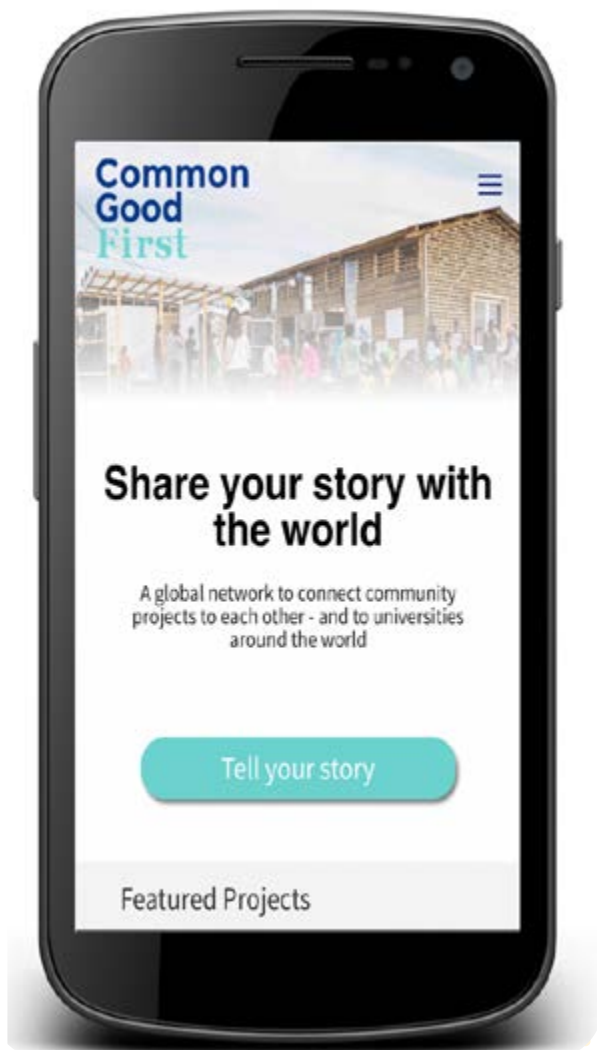
The Silindokuhle Preschool, designed by Kevin Kimwelle, is built from bottles and recycled wooden pallets. Kimwelle's work is featured on the Common Good First online website.

opens new possibilities to train the next generation of entrepreneurs. It's a different world educationally from case studies, simulations, and business plans.

Our key innovations include:

- Common Good First
- LEAP-Agri
- ICT4D-CC

Common Good First Digital Creativity Space

All communities, irrespective of their socio-economic status, have an exceptional ability to tackle social problems and find innovative solutions. From feeding and educating children, to overcoming gangsterism, to growing the township economy, the social innovation approaches developed in South Africa are remarkable. Many would have remained unknown, until Common Good First came along.

Common Good First is a partnership between several South African and international universities, where each of the universities identifies social innovation and community projects, including those with which they are engaged. The developer of the project and its primary coordinator is Glasgow Caledonian University (GCU) in Scotland. Nelson Mandela University in Port


Kevin Kimwelle

Elizabeth is the lead South African partner and coordinator.

GCU calls itself the University for the Common Good. Its research strategy centres around the UN Sustainable Development Goals and the university is a member of the Ashoka U network, a grouping of over 30 universities around the world who focus on social innovation. GCU is also one of the most successful UK universities in leading EU Erasmus+ social innovation grants and currently has four projects in progress, including Common Good First.

Launched in October 2018, the space referred to as Creativity@ Bird St, hosts amongst other a digital platform that serves as a collective showcase for social innovation, social enterprise and community projects in South Africa, and connects them to peer projects, academics and higher education institutions within the country and around the world. At the same time, it is growing
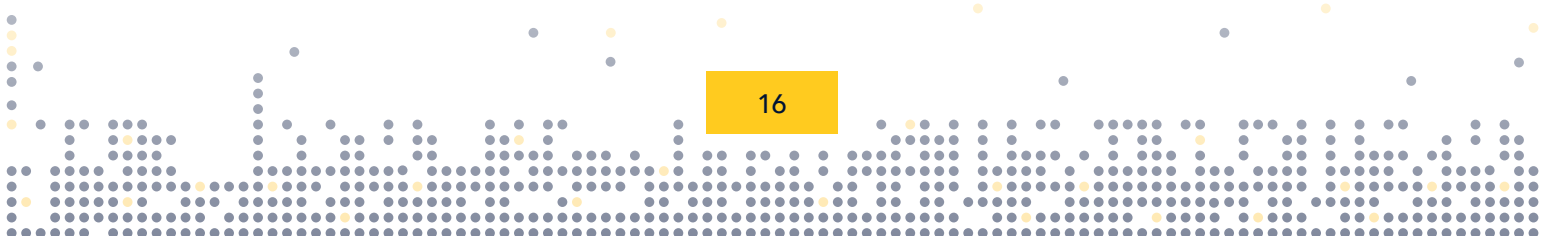
the participants' digital literacy and ICT skills so that they can optimally share their stories, skills, knowledge, information and solutions, and grow their support base and networks in South Africa, Africa and globally.

LEAP-Agri

LEAP-Agri is a programme of the EU-Africa Research and Innovation Partnership on Food and Nutrition Security and Sustainable Agriculture. It includes 30 partners, including 24 government ministries and funding agencies from 18 European and African countries who decided to join forces and funds to build an ERA-Net Cofund project, with the financial support of the European Commission. The 27 projects comprise 250 African and European teams from 20 countries, and they cover a large range of themes that contribute to sustainable agriculture and food systems in Africa.

The South African team will conduct an extensive baseline study in the remote areas of the Eastern Cape Province:

- To establish the needs and requirements of farmers and the types of crops they grow;
- To determine what factors influence the use and application of fertilisers; and
- To determine the current cost model of fertilisers in remote areas.

Based on the findings in the baseline study, the South African team will:

- Conduct laboratory-based experiments to determine the most suitable fertilisers for the Eastern Cape Province;
- Make recommendations for an improved costing model for these fertilisers;
- Develop an educational mobile app to assist farmers in remote areas to better manage their soil and crop fertilisation (including pest control) as determined by the various influencing local factors; and
- Make recommendations for the use of sensor technology to better manage fertiliser application by farmers in the remote areas of the Eastern Cape.

ICT4D-CC

The ICT4D-CC (Information and Communication Technologies for Development Competency Centre) is an interdisciplinary research centre in Portugal that comprises a team of international ICT4D experts. The partnership includes the CCT, the Centro de Informatica, University Eduardo Mondlane in Mozambique, Fraunhofer AICOS in Portugal and the Centre for Economics and Finance at the University of Portugal.

One of the projects undertaken through this partnership is CCT master's student Loic Ndame's wireless ICT monitoring app for the management of hydroponic agriculture in South Africa. This research was undertaken in partnership with small commercial hydroponic farmers in the Eastern Cape. The aim is to increase yields from hydroponic farming to contribute to food security in South Africa, and encourage more farmers to practise this environmentally friendly method.

Another project undertaken by CCT master's student Stephan Botha, developed the requirements for the use of mobile technology to support better soil management among small-scale crop farmers.

3. Educational Technology and Digital Participation

The CCT's research and development in educational technology focuses on developing prototype ICT systems to address critical educational problems in a wide range of teaching and learning environments: rural, urban and peri-urban. Using a combination of learner-centric and teacher-centric approaches, the CCT's novel technology solutions support educational objectives and contend with a variety of resource limitations, such

as limited or no internet connectivity, as well as limited access to textbooks. As with most ICT4D interventions, these solutions often include mobile technology and resource-appropriate adaptations of internet technology.

People around the world are embracing computing and digital media, using an array of devices, operating systems, local media sharing and cloud-based services. Increasingly affordable consumer electronics have expanded the number of contexts in which media, educational games and other software can be accessed. This technology has enhanced the CCT's ability to create, share and interact with and around various forms of media used in an educational context.

Drawing on user-centred, ethnographic and action-research approaches, the CCT's Digital Participation focuses on technologies in use in a wide range of contexts, such as homes, libraries, clinics, classrooms, community healthcare, after-school and holiday programmes. At the same time, the CCT draws on these contexts to better understand the economic, social and power dynamics that come into play as people access, use and create digital media. This research, at the intersection of creative arts, anthropology, linguistics, information technology and media studies, is inspired by the need to understand agency and obstacles to digital participation.

Our key innovations include:

- eReady Project
- Learn2Code
- E-skills and digital skills training
- FishForce
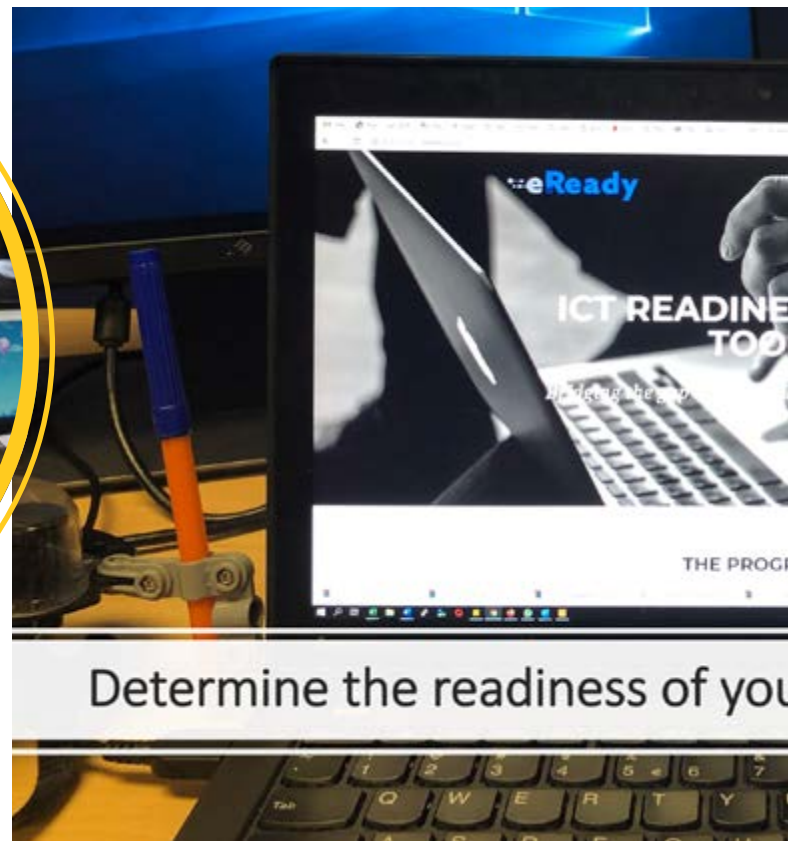
eReady Project

ICT has the potential to enhance the education, management and administrative capacity of all schools in South Africa. Recognising this, through the departments of Performance Monitoring and Evaluation, Basic Education, and Science and Innovation, the government is implementing Operation Phakisa: ICT in Education, with the objective of transforming education service delivery.

To enable this process, a decision support tool is needed to inform policymakers and decision makers on the state of readiness of all government schools in the country to receive ICT infrastructure. South African schools, especially in rural areas, have a range of challenges in this regard, including poor building infrastructure, no electricity and no connectivity.

The CCT is working with government on a national project to assess eReadiness at all government schools, using the Schools ICT Readiness Assessment Framework (eReadiness) decision support tool. Towards developing the tool, a three-year pilot in the use of ICTs in education was conducted through the Technology for Rural Education project in Cofimvaba in the Eastern Cape. This was done in collaboration with the Council for Scientific and Industrial Research (CSIR) to demonstrate the extent to which ICTs can contribute to improving the quality of education.

The benefit of the Schools ICT Readiness Assessment tool is
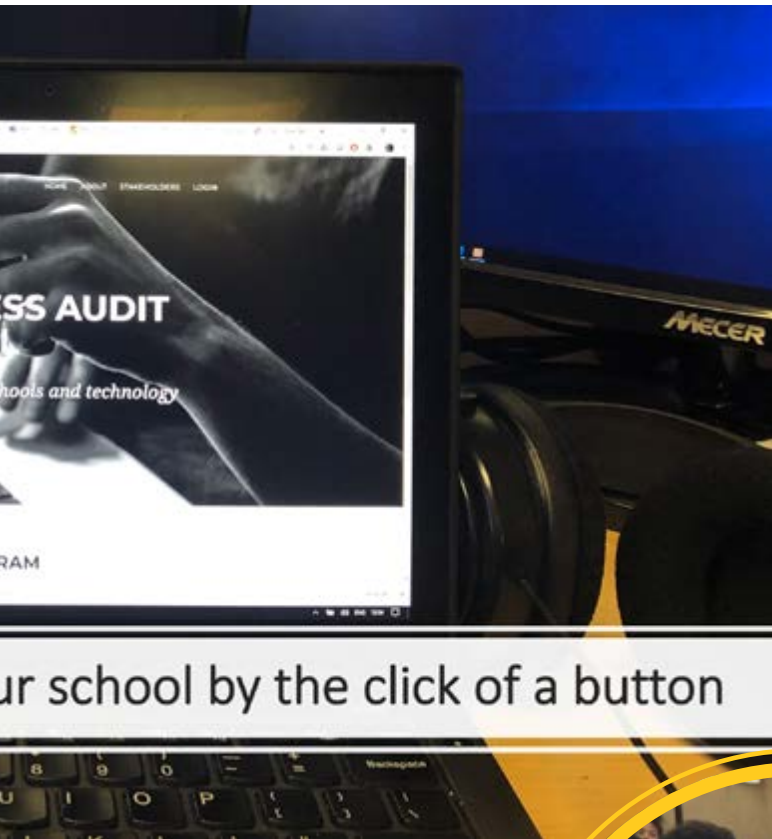
Level 4 – High ICT capacity
Level 5 – Advanced ICT capacity

Role of the CCT

- To refine, pilot, test and further develop the current Schools ICT Maturity Assessment tool.
- To engage with the Department of Basic Education and secure their buy-in and input in the refinement and piloting of this tool.
- To engage with the ICT-in-education stakeholder community and showcase the final product through a seminar once the tool has been piloted and tested.
- To produce a policy brief, articulating policy implications, based on the pilot process and in line with the DSI policy brief standards.

Learn2Code

The lingo of today's learner is mobile phone technology. The CCT creates innovative apps and support structures to assist learners with their studies through a fun, immersive approach. The CCT's Learn2Code programme has been running since February 2017 and teaches Grade 6 and 7 learners from low income schools in Port Elizabeth's northern suburbs how to code. The learners are taught computer skills and coding using software called Scratch.

that each school's ICT readiness level can be assessed before any intervention to enable ICT-based education is deployed. Improvement plans can be actioned according to the ICT readiness level (or lack of it) and the conditions in each school.

The decision support tool assesses the level of ICT readiness and maturity for each school across five perspectives, namely:

- ICT infrastructure
- Connectivity
- Curriculum and digital content
- e-Administration
- Teacher development and support

These readiness perspectives are assessed individually and/or collectively across five levels. These are:

Level 1 – Under-developed ICT capacity
Level 2 – Poor ICT capacity
Level 3 – Moderate ICT capacity

Learn2Code is run by the CCT's Afikile Sikwebu and funded by the CCT and Nelson Mandela University's Research Fund.

"The power to code and create is strong within every young person," says Sikwebu. "Through Learn2Code they start to open their minds to higher education and career opportunities, and all the entrepreneurial possibilities that coding languages offer."

Droning by Kite

As part of its Learn2Code programme, the CCT uses fun software coding techniques such as "Droning by Kite" to teach primary school children in disadvantaged communities to do basic software coding, which develops their maths and IT ability.

"All children love to play and explore," says Sikwebu. "Droning by Kite teaches primary school learners to make their own 'kite drones' using available materials for the kites, to which they attach cellphones that are set up to capture video footage from above. Science, Technology, Engineering, Arts, Mathematics (STEAM) skills are an integral part of the exercise. For example, learners need to calculate the dimensions of the kite to ensure it

corresponds with wind velocity and resistance. The kites also have to be sturdy enough to hold the cellphone.

"The Xhosa saying, *umthi ugotywa usemanzi* (start them young) stands true, as we introduce learners to the use of technology from the age of 10."

FishFORCE

Organised crime with a link to the illegal harvesting, processing and trading of fish and seafood is so huge globally that it is in effect a parallel economic system that is undermining sustainable economic growth. In response, Professor Hennie van As, admitted advocate and public law professor at Nelson Mandela University, founded and heads FishFORCE, South Africa's first Fisheries Law Enforcement Academy.

"FishFORCE was established in 2016 with the aim of achieving knowledge and intelligence led investigations and prosecutions of criminals engaged in fisheries crime in Africa and globally, and to train officials involved in

the fight against fisheries crime," says Van As. FishFORCE is a partnership between Nelson Mandela University, the Norwegian Ministry of Foreign Affairs and South Africa's Department of Agriculture, Forestry and Fisheries (DAFF). It has buy-in from Interpol, the African Union and the United Nations Office on Drugs and Crime.

The CCT is assisting FishFORCE with the development of mobile apps and online platforms for fisheries law enforcement officers and to assist all role-players in the fisheries-related criminal justice system.

The CCT built a portal for managing the online learning content which can also be accessed on a mobile phone. The portal offers the user functionality, such as identification of fish species, capturing of evidence during investigations, information regarding the correct procedures and formulation of charges in terms of law enforcement and information related to specific fisheries crime situations.

Collaboration at local, **national** and **international** levels

Gender Specialist
Professor Larry D. Icard

CCT research associate Professor Larry D. Icard specialises in gender and LGBTQ issues. Together with the CCT he is researching ways to use digital platforms to address gender stigmas in order to optimise HIV care among HIV positive males, and males who have sex with males. The aim is also to expand this research to gender-based violence (GBV).

Public Health Specialist
Dr Stefanus Snyman

Medical doctor Dr Stefanus Snyman is a public health specialist based in Cape Town. He was formerly with Stellenbosch University and now works as a locum at community clinics. He partners the CCT in all digital health projects to ensure that what we do adheres to medical standards and requirements. He has a specific interest in mental wellness and cancer.

Cyprus University, IT Solutions for Disabled Persons Specialist
Dr Alexandros Yeratziotis

Dr Yeratziotis specialises in IT solutions for disabled persons. Professor Darelle van Greunen supervised his master's and PhD, and his brother George Yeratziotis' master's. Both have developed several apps that are available globally to teach people how to learn all the different sign languages of the world.

Human-Computer Interaction Expert
Professor Paula Kotze

Prof Kotze is a Pretoria-based Adjunct Professor of Nelson Mandela University, formerly of UNISA and the CSIR, now retired. Her expertise is in human–computer interaction and she was Professor Darelle van Greunen's PhD promoter. She is a formidable figure in the South African and global computer science landscape, with many accolades. The last 12 PhDs she supervised all became professors within two years of obtaining their PhDs, and they are working throughout the world. She co-supervises postgraduates with Prof van Greunen.

Public Health and Chronic Disease Expert
Prof Maggie Williams

Prof Williams holds a PhD in Nursing Science. Her focus area is tuberculosis, HIV/AIDS, malnutrition and child health. Her research also focuses on community engagement in line with health promotion.

Grants

The CCT has secured grant funding from a number of national and international organisations and foundations. Three of the CCT's key grants are:

European Union
mHealth4Afrika (Mobile Health For Africa)

The €3 million mHealth4Afrika project, led by Professor Darelle van Greunen, is the only European Union-funded Horizon 2020 or H2020 project that was awarded to South Africa out of seven national submissions. Horizon 2020 is the biggest EU Research and Innovation programme ever undertaken, aimed at achieving breakthroughs, discoveries and world firsts by taking great ideas from the lab to the market.

European Union
Common Good First

Common Good First is funded by the European Union's Erasmus+ programme, a funding stream open to school and youth education, further and higher education, and adult education. In 2016, Erasmus+ received 736 applications, of which 147 projects were funded, one of them being Common Good First, which was awarded an amount of almost €1 million over three years (approximately R15.5 million) with Glasgow Caledonian University (GCU) as the European lead and the CCT at Nelson Mandela University as the South African lead.

Discovery Foundation Rural Fellowship Award

Professor Darelle van Greunen was awarded a R1 million Discovery Foundation Rural Fellowship. It is being used in the development of a mobile application aimed at reducing the high drug-susceptible TB burden in the Nelson Mandela Bay Metro.

The Discovery Foundation Rural Fellowship Award receives hundreds of applications and nominations annually. It is mostly awarded to medical researchers and healthcare practitioners. It is a rare privilege that this prestigious award was made to an ICT person.

Technology Innovation Agency (TIA)

Prof van Greunen is one of three researchers at Nelson Mandela University who received R650 000 from the Technology Innovation Agency (TIA) as seed funding to further the CCT's Digital TB (tuberculosis) solution (DigiTB). This includes extending the mobile app developed by the CCT in 2017/18 to reduce the Drug-Susceptible TB burden by including eCounselling, eFAQ, adding biometric recognition to ensure compliance to treatment, and extending the pilot beyond Nelson Mandela Bay to include rural communities.

Noteworthy
Postgraduate Research

PhD
Healthcare Research Theme

- Dr T Adebesin (2015): A method for the selection of e-Health Standards to support interoperability in healthcare information systems
- Dr A Petratos (2017): A mobile health framework to manage Type 2 diabetes
- Dr S Ouma (2014): M-Health user experience framework for the public healthcare sector
- Dr A Yeratziotis (2012): A framework for evaluating usable security of online health social networks.

Digital Participation
- Dr J T Medupe (2019): A strategy for sustainable ICT for development in deep rural environments

- Dr N Mpekoa (2017): A framework for M-voting implementation in South Africa

Co-Creation
- Dr J Mashapa (2014): A model for managing user experience
- Dr H Van de Haar (2014): A framework for biometrics for social grants in South Africa

Master's
- M Buckle (2019): User experience requirements for the integration of blended learning technologies into anatomy and physiology
- Ulza Wasserman (2018): Guidelines for and evaluation of the design of technology-supported lessons to teach basic programming principles to Deaf and Hard of Hearing learners: A case study of a school for the Deaf

Left to right: Prof Darelle van Greunen and Alida Veldsman, and Afikile Sikwebu and Dr Kevin Kativu at graduation.

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