Shaping the future of science for society

Professor Azwinndini Muronga
Executive Dean of the Faculty of Science
Nelson Mandela University

Science is hope

Through science we are looking at the future and contributing positively to the protection of our complex natural environment and physical systems for the benefit of all life, including humankind.

It gives us hope for a better world, and what we can achieve.

There are no laws of science that demand poverty, inequality and destruction.

These are human-made phenomena and humans can end them.

The grand challenges that include climate change, environmental and biodiversity degradation, socio-economic and food insecurity and pandemics, require the sciences to work together with the humanities, governments and civil society to find solutions.

As the Faculty of Science at Nelson Mandela University, we strive to address the grand challenges on a national, continental and global scale, with a focus on the UN sustainable development goals (SDGs), the Africa Agenda 2063 and the goals of SA's Department of Science and Innovation (DSI) White Paper (policy) and its decadal White Paper implementation plan.


Professor Azwinndini Muronga

To achieve this, we need to be Africa-focused while being globally influential and impactful.

We need to contribute to innovation and knowledge in the industrial revolutions of the 21st century, which include digital transformation and a fleet of new careers and opportunities. Preparing our students for life and the future world of work requires the inclusion of new disciplines and areas of growth, including computational and data sciences.

We also focus on entrepreneurship education and transformation.

Our Faculty of Science anchors transformation in the philosophy of diversity, equity, and inclusion in the sciences, including diverse ideas, fit-for-purpose programmes and demographic diversity in the student and staff composition.

At the same time, all universities need to be engaged in building and nurturing the culture of learning and teaching in our communities from the earliest age, because this is our knowledge pipeline.

We need a seismic shift in the national and provincial educational policy; it calls for a policy that is enabling of a new model for learning and teaching which recognises and nurtures every learner's potential to achieve in subjects such as maths and science, instead of continuously lowering the pass rates.

We have to do this

If you want to destroy a nation you should attack its education system and if you want to defend your nation you should have a strong culture of education, innovation and

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Nelson Mandela University's Faculty of Science

Our Mission:
To offer a diverse range of life-changing pure and applied science-based learning, teaching, research, training, innovation, engagement and transformational experiences, which develop excellent graduate and staff attributes for sustainable futures.

Our Vision:
To be a world-class engaged and trans-disciplinary African Faculty of Science that responds to socio-economic and environmental challenges in society.

Future world of work Page 2

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Light on dark energy Page 3

100 years of physics — the past, the present and the future

2022 was the centenary of the International Union of Pure and Applied Physics, of which SA is one of the 13 founding members and which now has 60 member countries.

It was also the International Year of Basic Sciences for Sustainable Development.

These celebrations came at a critical time, as the UN Educational, Scientific and Cultural Organisation (Unesco) has highlighted that the basic sciences are being neglected worldwide.

This has led to a state of serious vulnerability in disciplines such as physics, mathematics and statistics, all of which are key to innovation, development and the future world of work.

Also known as the fundamental sciences, the basic sciences include physics, biological sciences, chemistry, mathematics, statistics, computer science and geological sciences.

The reason for the basic sciences not receiving anything near sufficient support in terms of funding, is because it is difficult to convince governments and funding agencies to properly resource fields that take time to yield results, but when they do, the results are life-changing.

The basic sciences include physics, biological sciences, chemistry, mathematics, statistics, computer science and geological sciences

Only now are gravitational waves being detected, as Einstein predicted in 1916.

Inventions like GPS would not work without Einstein's theories of relativity.

Over the past 150 years, basic scientists have achieved fundamental advances, such as quantum mechanics, genomics, antibiotics, plate tectonics, nuclear fission and fusion, the X-ray, the theory of evolution, and the internet/world wide web — a by-product of particle physics research at CERN (the European Organisation for Nuclear Research).

BACK TO BASICS: A gathering of Africa's top physics students at ASP 2022 at Nelson Mandela University. Picture:HEATHER DUGMORE

Science students are inspired to solve Africa's problems

Gillian McAinsh

Senior students invited to participate at the 2022 edition of the African School of Fundamental Physics and Applications (ASP2022) went home inspired and enriched through their encounters with other bright sparks from all over Africa.

From Algeria to Zimbabwe, more than 100 of Africa's top final year and postgraduate physics, mathematics, engineering and computer science students, including 60 from South Africa, converged on the Faculty of Science at Nelson Mandela University in Gqeberha, Eastern Cape. A further 100 African students throughout the continent participated online from 28 November to 9 December 2022.

The ASP is a continental school that started in 2010 to build capacity in physics in Africa and is held in a different African country every two years.

The students were selected from hundreds of applicants and spent two weeks at the Faculty of Science doing intensive hands-on training and participating in lectures from about 40 international experts. A few of them share their experience below.

SAMUEL WORKU

CHISENGA MUSUNGAILA

GLORIA KATUNGE

FATIMA BENDEBBA

DIMAKATSO MANESO

AMOGELANG MOENG

AUGUSTIN SOKPOR

ARNOLD MUTUBUKI

Ethiopia: Samuel Worku

Samuel Worku, 29, who recently graduated with his MSc in astrophysics, takes a keen interest in dark matter.

"It has been my dream since school to know and understand how our universe works, but it is also important because it can solve so many problems we face in Africa.

"For example, we lack technology and medical laboratories in Ethiopia. Since I also have a background in computer science, I want to help change many of our manual systems to digital systems.

"I have big plans to use science to solve complex problems!"

Eswatini: Chisenga Musungaila

Fourth year physics and mathematics student at the University of Eswatini, Chisenga Musungaila, 26, aspires to be a nuclear physicist.

"When I grew up, I wanted to know why the sky was blue and why airplanes looked so small in the sky.

"I was curious, and physics answered my questions.

"The basic sciences are important for problem solving, they are the foundation of our entire existence and physics specifically can help to curb some of the issues in the continent. At ASP I've seen different perspectives from people who have done so much for Africa and physics. It is really capacitating."

Kenya: Gloria Katunge

Gloria Katunge, 26, is focusing on materials science for her MSc at the University of Nairobi, driven by her desire to solve societal problems.

"Physics holds a lot of promise for Africa because it is the surest solution to daily challenges such as water shortages and power outages still faced by developing countries.

"My ultimate career goal is to be a solar specialist and help resolve power issues across the globe.

"This [ASP] has been a life-changing experience as I have learnt a lot of physics concepts and how they apply to real life settings. This will go a long way in shaping my future as a physicist."

Morocco: Fatima Zahra Bendebba

Fatima Zahra Bendebba, 27, is a doctoral student in high energy physics at Hassan II University of Casablanca.

"The lectures have taught us a lot about accelerators and particle physics, which are two of my favourite fields.

"I also hope I will have the chance to benefit from the internship at Brookhaven National laboratory in the US, and eventually obtain a postdoc position after my PhD.

"I hope to take part in ASP2024 in Morocco – but this time as a lecturer to share my experience with new ASP participants!"

ASP has shown me how we can use our knowledge to solve problems. – Dimakatso Maheso

South Africa: Dimakatso Maheso

University of Johannesburg MSc student Dimakatso Maheso, 23, is interested in astrophysics.

"I love physics because I am intrigued by nature and why it operates the way it does. Now, I understand it better.

"Physics has applications in almost all industries and ASP has shown me how we can use our knowledge to solve problems. Using my knowledge is far more powerful than just having it. Also, it showed me that I do not have to solve all of Africa's problems – I can start with my community and then expand from there."

When I grew up, I wanted to know why the sky was blue and why airplanes looked so small in the sky. I was curious, and physics answered my questions.

– Chisenga Musungaila

South Africa: Amogelang Moeng

Amogelang Moeng, 27, is studying astrophysics for her masters degree at the University of Johannesburg.

"Science shapes our world and tells a story of where we come from, where we are right now, and where we are going.

"The school has been very intense but so exciting at the same time, and I have learnt new concepts that align with my current project.

"I have also had the opportunity to make new friends from across Africa and I hope to collaborate with most of them on projects. The future looks exciting!"

Togo: Augustin Sopkor

Augustin Sokpor, 25, who holds an MSc in Physics from Université de Lomé, sees physics as key for developing the continent.

"This has helped me to understand atomic and nuclear physics. It opened my mind on particle accelerations and on the Big Bang theory, and it also showed me what other countries are doing in terms of scientific research."

Zimbabwe: Arnold Mutubuki

MSc Physics student Arnold Mutubuki, 29, is an international student at Nelson Mandela University in Gqeberha. He is interested in nanophotonic materials.

"Physics is essential to understanding our modern technological society and it is significant that 2022 was the International Year of Basic Sciences for Sustainability.

"Physics has the potential to transform Africa in all sectors of industry.

"This school has exposed me to a larger world of physics, from learning about the smallest known particles to appreciating the existence of dark matter. I have been following closely lectures on particle physics, accelerators, radiation and medical physics, materials physics, and nanoscience.

"It has been a great platform to network with highly esteemed physicists from different parts of the world.

"I now have a broader vision of how physics can transform our continent."

I now have a broader vision of how physics can transform our continent. – Arnold Mutubuki

Science is fun, join us!

"Science is fun, join us!" is Dr Raïssa Malu's call to all students throughout Africa.

A physicist and international STEM educational consultant from the Democratic Republic of the Congo (DRC), Dr Malu was educated in Belgium at the Catholic University of Louvain and worked as a computer scientist in the banking sector, a research assistant in the nuclear sector and a lecturer in higher education, before returning home eight years ago.

Speaking at ASP2022, Dr Malu said: "In 2011 when I visited Kinshasa to present the maths education book that I had authored, to teachers, I realised it was more important to work in the DRC than in Belgium. I returned home to promote STEM among young people, teachers and all citizens."

"My whole goal is that I don't want maths and science to be barriers to our students.

"I want these subjects to be fun and I want students from throughout Africa to know what wonderful careers they can pursue in subjects like physics," says Dr Malu, who has also authored books on physics and published one on chemistry education.

In 2013, she founded a non-profit in Kinshasa called Investing in People, that organises the annual science and technology week in the DRC to promote STEM among young people and citizens.

"Working together with the Ministry of Education, we are reforming the teaching of maths, science, technology and innovation at schools and universities," she explains.

PASSIONATE EDUCATOR: Democratic Republic of the Congo physics and maths educator Dr Raïssa Malu, centre, with students from the University of Lesotho, Mathai Ramahlele, left, and Mosa Masupha at ASP2022. Picture: HEATHER DUGMORE

EXCITED TO LEARN: The annual Science and Technology Week in the DRC promotes STEM among young people and citizens throughout the country. Picture: INVESTING IN PEOPLE

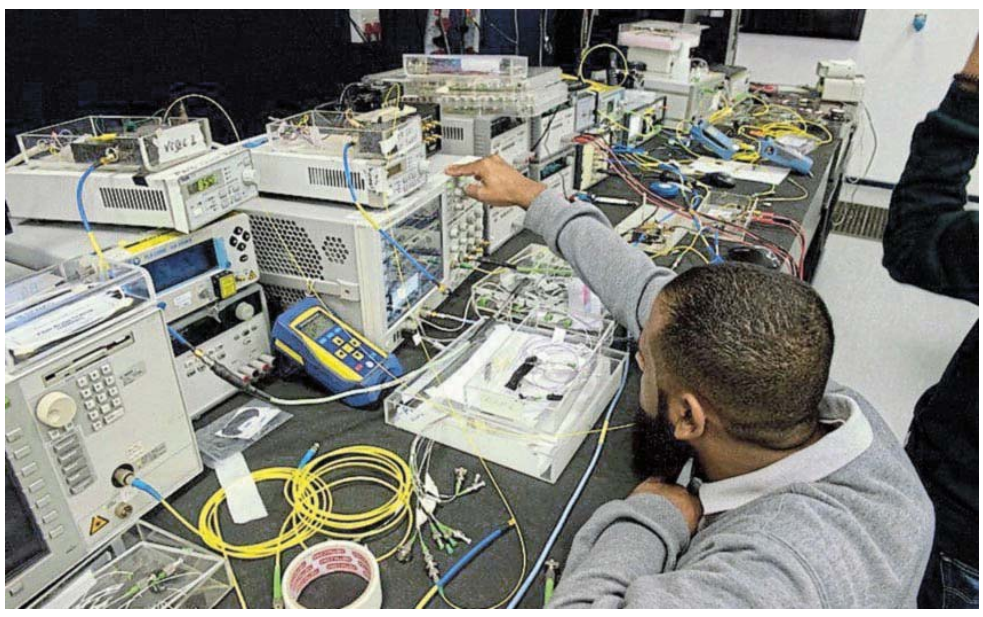
"Over the past decade there has been a considerable increase of students in the DRC wanting to study STEM subjects, including far more women students."

The DRC has 92 million people, of whom 54% are under the age of 18.

There are 6.8 million pupils in high school and 564,000 undergraduate students at the country's 272 universities and higher education institutions. "As with all countries, some of these are of a very high standard, others are not and we are working on improving the general standard in all parts of the country," says Dr Malu.

Dr Malu's personal physics journey was inspired by her mother, Mariette Thienza, and her late father, Professor Félix Malu wa Kalenga, an internationally accomplished engineer and nuclear physicist in the DRC, who was head of the country's nuclear centre, as well as a proponent of new sources of renewable energy, producing one of the first studies about the energy demand for the development of Africa. She adds that her father and Ghana's foremost professor of mathematical physics, the late Professor Francis Kofi Ampenyin Allotey, were the only black scientists in big science in the second half of the 1900s.

"Today that has changed but we still want to see far more big science contributors from the continent and we're working on this."



GLIMPSE INTO THE FUTURE: The offshoot from big science is that the technologies developed for it will be in our homes in a few years' time. WiFi, for example, was invented by astronomers for big science projects; webcams were invented to remotely monitor science research.

Leading in big science — project exploring space

"Physics tells the story of the universe. It equips us with tools to invent technologies that discover and shape a new and better world." — Professor Tim Gibbon, director of the Centre for Broadband Communication (CBC), who received the 2021/2022 Distinguished International Associate award from the British Royal Academy of Engineering.

The CBC's contribution to big science projects includes radio astronomy (the Square Kilometre Array (SKA), MeerKAT, HIRAX); 5G telecommunications; robots that explore the oceans; and geosensors that detect earthquakes and sinkholes to save lives.

In 2021, Nelson Mandela University, through the CBC, joined as a full member of the prestigious HIRAX project, led by the University of KwaZulu-Natal. "Our research group of physicists contributes expertise in optical fibre links," Prof Gibbon said.

"HIRAX (hydrogen intensity and real-time analysis eXperiment) is a novel radio telescope interferometer, in design.

"It will comprise roughly 1,000 closely-packed six-metre dishes, deployed at the SKA site in the Karoo."

HIRAX will map most of the southern sky to measure remnant ripples in the distribution of galaxies that are imprinted by primordial sound waves which existed in the early universe. This will be used for charting the history of the universe and for shedding light on the nature of dark energy.

DRIVING FORCE: Professor Tim Gibbon

"The offshoot from big science is that the technologies developed for it will be in our homes in a few years' time," Gibbon said.

"WiFi, for example, was invented by astronomers for big science projects; webcams were invented to remotely monitor science research."

Free maths and science tutoring for Grade 11 and 12 learners

Vuyani Chipunza never expected to become a maths and science celebrity, but these days he is stopped in the streets by learners asking if he is "that Vuyani from Yebo Tutor". He most certainly is. He is one of several skilled tutors in the Centre for Broadband Communication (CBC) at Nelson Mandela University who livestream extra lessons for Grade 11 and 12 maths, physical science and life science learners anywhere in South Africa.

SKILLED TUTOR: Yebo Tutor final year Engineering student Vuyani Chipunza.

Subscription is completely free on the Yebo Tutor livestream channel on YouTube:

https://www.youtube.com/c/YeboTutor

"My wish is to help as many learners as possible to do well in science and maths so that they can gain access to university, which is why I joined Yebo Tutor," says Chipunza who is a final year student doing his engineering degree in mechatronics at Nelson Mandela University.

Yebo Tutor was conceived during the COVID-19 pandemic by the Director of the CBC, Professor Tim Gibbon. Last year, a group of physics and science tutors piloted it with Grade 11 and 12 learners.

"We currently have one hour of livestream tutoring in maths, physics and chemistry three times a week and we want to exponentially grow the model to reach as many learners and teachers as possible throughout South Africa," says Prof Gibbon.

Learners anywhere can access the Yebo Tutor on any device or teachers can go online and their entire class can benefit from the tutorial, and teachers can enhance their skills too.

While the tutors are livestreaming, learners can type their questions on YouTube or click on a link and call into the tutor and ask their question.

There is also a WhatsApp group linked and they can submit questions this way too.

Yebo Tutor's potential return on investment is phenomenal because one tutor can help hundreds of learners everywhere to succeed in maths and science in matric, and to gain access to South African universities.

There are not nearly enough university enrolments in these subjects which are critical for research, innovation and the future of work. We all know there is a huge shortage of qualified science and maths teachers in South Africa and this is an economical, fast-track method to overcome the problem fast.

"It's pretty amazing because all we need to reach the learners is a micro studio with high production quality and green screens, says Prof Gibbon.

"The whole studio, which can be set up in a small lab space or the tutor's home, costs between R30 – R40 000.

"If we can get funding to sponsor airtime and the operating side of Yebo Tutor, we can have 10 or 20 microstudios up and running, along with 24-hour live help for all learners across South Africa.

It's the Uber of education."

Charting the way forward for physics in Africa

Gillian McAinsh

The future of physics in Africa looks bright, according to insights shared in a forum with international policymakers in this field.

The forum to chart the path ahead for science education and research on this continent was part of the African School of Fundamental Physics and Application (ASP) held at Nelson Mandela University in November and December. Academics, policy makers and scientific industry leaders lent a global perspective, in interactive panel discussions, on how to develop policy ahead of ASP2024, which will be held in Morocco.

Prof Oumar Ka of the Senegal Physics Society, addressing the school remotely, spoke on behalf of the African scientific community and outlined how ASP was funded.

SCIENCE GATHERING: Guest speakers and visitors at the African School of Fundamental Physics and Applications conference Forum Day included, from left, Livhuwani Masevhe of the Department of Science and Innovation (DSI), SA National Space Agency acting CEO Andiswa Mlisa; Lindiwe Gama of the DSI and Michael Nxumalo of the National Research Foundation. Picture: GILLIAN MCAINSH

International support for physics in Africa

Numerous sources, including but not limited to CERN, the International Centre for Theoretical Physics, INFN (Italy's National Institute for Nuclear Physics), Physical Sciences Inc, Fermilab, Brookhaven National Laboratory (BNL), the National Science Foundation, and the South African Institute of Physics contribute.

"An average of 23 countries support the ASP per edition and South Africa is a heavyweight in this," Prof Ka said, urging continued sustainable funding.

Other panellists shared how their organisations could assist

West Africa in particular showed strong support with delegates from the ministries of higher education in Benin, Burkino Faso and Ivory Coast, contributing to the debate online.

Burkino Faso, for example, has passed a law that allows for national industries to contribute to a science research and development fund.

"We want to build capacity in Africa"

South Africa's Department of Science and Innovation representative Lindiwe Gama outlined how the department hoped to create an enabling environment for partnerships and research to expand.

"Speaking to our counterparts in the African countries, we are so eager and passionate about the pan-African science agenda," said Gama.

"We want to build capacity in Africa, and grow together so that there is no brain drain but rather brain circulation."

Funding was still a challenge, however, as less than 1% of GDP was invested in science, technology and innovation, said Gama.

The panellists listened to the voices of students and young researchers, many of who cited lack of infrastructure and other challenges in their countries.

Dr Gopolang Mohlabeng – a South African astrophysicist who now works in the US – spoke from personal experience on why early career physics scholars may leave Africa for other continents.

In response, South African Institute of Physics President Prof Makaiko Chithambo highlighted capacity development and retention strategies aimed at addressing these challenges. As Gama had noted, South Africa has signed agreements with 28 African countries to enhance collaboration between scientists, which students could also benefit from.

SA's National Research Foundation (NRF) spokesman Michael Nxumalo also suggested that ASP could grow into a school with multiple satellite venues which would enable more students to attend.

"This [ASP2022] is an exciting initiative and we are here to ensure that support is expanded," said Nxumalo. "Whether or not you are students of physics, we want you all to be problem solvers. We are training today's leaders so we need to put more resources into training."

"Space is for society"

Andiswa Mlisa, acting CEO of the SA National Space Agency, spoke on capacity development and retention strategies through the lens of space science and technology programmes in South Africa and Africa.

"Space is for society. Space science brings prosperity and that is one of the major reasons that we advance space science. No one must be left behind," said Mlisa.

SANSA's vision is an integrated national space capability that responds to socio-economic challenges, contributing meaningfully to development across the continent.

Speaking online from the US, Brookhaven Deputy Director for Science and Technology Prof Robert Tribble looked at the opportunities brought by the BNL-SA Physics Consortium. Brookhaven is one of 17 US national laboratories under the auspices of the Department of Energy.

He noted it had an annual budget of "about $700 million", and a strong partnership with New York State, where it is located.

Looking ahead to Morocco in 2024

Presenting online from Morocco, Prof Abdeslam Hoummada, the director of Sciences

at Hassan II Academy of Science and Technology in Casablanca, shared plans about the next destination of the African School of Physics in 2024.

One ASP alumnus, Dr Mounia Laassiri of Morocco, outlined how its initiatives and programmes had contributed to her career in science.

She noted: "ASP has opened my mind in so many ways: academically, socially, morally. I will forever be grateful to have had this privileged scientific adventure!"

Shaping the future of science for society

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new knowledge generation.

As a faculty, we encourage our students and staff to think radically, away from outdated knowledge and thinking.

Phrases such as 'this is how it has always been done' have to give way for new, diverse and inclusive ideas.

In 'The Structure of Scientific Revolutions' by American physicist, historian and science philosopher, Thomas S. Kuhn, he explains that the history of science teaches us that major scientific breakthroughs only happen because of radical thinking, away from the norm or traditional scientific thinking.

We are living in very exciting times

Major scientific breakthroughs have happened over the past six years, including the detection of gravitational waves from far away galaxies as a result of black hole and neutron star collisions.

This finding led to a Nobel Prize in 2017. In 2019 the Nobel Prize for physics was awarded "for contributions to our understanding of the evolution of the universe and Earth's place in the cosmos".

The Nobel prize for physics 2021 was a joint award to oceanographers and climate modellers Syukuro Manabe and Klaus Hasselmann for "the physical modelling of Earth's climate, quantifying variability and reliably predicting global warming".

Their work laid the foundation for the development of current climate models, knowledge of the Earth's climate and how humanity influences it.

And the Nobel Prize in physics 2022 was awarded jointly to Alain Aspect, John F. Clauser and Anton Zeilinger "for experiments with entangled photons, establishing the violation of Bell inequalities and pioneering quantum information science".

Their results have cleared the way for new technology based on quantum information.

Looking to the future of science, we have an incredible opportunity on our doorstep with the Square Kilometre Array (SKA), one of the world's largest science projects, which SA is hosting with other African countries and Australia.

In the same vein, SA and Morocco are participating in international research collaborations such as the Large Hadron Collider (the world's largest and most powerful particle accelerator) at CERN in Switzerland and other accelerators around the world.

It is all about advancing the boundaries of human knowledge to understand our universe and push the frontiers of technology and understanding for the benefit of society.

What we need to do now as a country and university sector is to provide the necessary resources to grow the pipeline of postgraduates to participate in finding solutions to the grand challenges.

The good news is that change is entirely within our power.

Careers in high demand and ways of contributing to Africa

Heather Dugmore

Dr Kétévi Assamagan (left) and Prof Azwinndini Muronga at ASP202. Picture: GILLIAN MCAINSH

"African students who study accelerator physics and big data analysis can contribute to huge collaborations worldwide. The continent does not have a lot of people in this vast field, which is essentially about accelerating particles to probe the nature of matter and life in the universe. Students who pursue this are in high demand," says nuclear and particle physicist Dr Kétévi Assamagan from Brookhaven National Laboratory (BNL) in the US who is the co-founder of the African School of Physics (ASP) and a member of the international organising committee.

Assamagan who is originally from Togo commented on the large number of talented young scientists from all over Africa at ASP2022, 28 November - 9 December 2022.

"A lot of work needs to be done to ensure Africa capitalises on its intellectual capital and develops more capacity to drive developments in basic research and applied physics. To achieve this, African countries need to collaborate with each other and internationally to share resources and expertise."

To contribute to the development of African physicists since the founding of ASP in 2010, mentors are paired with participating students and visits to labs like BNL are arranged for selected students.

"The mentors have ongoing engagement with the students and they follow their academic growth," he explains. "We measure ASP's success on a long-term basis, from the number of alumni achieving PhDs and postdoctoral research, and we can see the impact of the past 12 years. We also survey alumni, university professors and students to help us improve in achieving our goal of exciting more students to pursue careers in physics and the other basic sciences."

BNL has a programme where it invites African scientists to pursue their research at its lab. In 2017 a group from BNL visited South African universities, iThemba LABS (Africa's leading research facility for accelerator based science) and the Department of Science and Innovation to see how they can develop a comprehensive framework for physics collaboration and enable African physicists to pursue their research at BNL.

Dr Assamagan joined BNL in 2001, following time spent at CERN – the European Organisation for Nuclear Research – where he was a research scientist working on the ATLAS experiment. ATLAS is the largest-volume, multi-purpose detector ever constructed at a particle collider. He was part of the collaboration that discovered the Higgs boson.

His research focuses on the search for physics beyond the current Standard Model of particle physics.

Dr Assamagan well knows the journey of many African physicists. "I grew up in a village in Togo with no electricity or running water. My mother never attended school and my father was an auto mechanic. They wanted me to study medicine, but being the oldest of eight siblings I felt I needed to do a degree that didn't take as long so that I could help support my family, and chose to do a BSc at the University of Lomé. Little did I realise the lifelong career in academia that awaited me."

After getting his degree, he was awarded a scholarship by the African-American Institute to continue his university education in the US. He obtained his MSc from Ball State University and his PhD from the University of Virginia in 1995. A postdoctoral research fellowship followed at Hampton University's Jefferson Lab, where he participated in the commissioning of the Continuous Electron Beam Accelerator Facility (CEBAF), followed by his move to CERN to work on ATLAS.

A lot of work needs to be done to ensure Africa capitalises on its intellectual capital and develops more capacity to drive developments in basic research and applied physics. To achieve this, African countries need to collaborate with each other and internationally to share resources and expertise

"One of the issues we address as African scientists is the retention of skills on the continent," he explains. "Many of us get our first degree in our home country and then we are offered opportunities to pursue further studies abroad.

"We integrate into those societies, we find opportunities and establish families.

"It is not always possible to physically return home to contribute to the development of science in Africa, but there are different ways of contributing, such as I am heavily involved in Africa through ASP and mentoring groups of students from Africa. The world is a global space and we can participate online to lessen the brain drain from wherever we are. The digital world opens up far more opportunities, activities and research partnerships that can serve Africa and the world more than ever before," said Dr Assamagan.

Dr Mounia Laassiri had fun with learners at the Nelson Mandela Bay Science and Technology Centre.

International 'space benders' inspire youngsters

An international group of scientists inspired young learners to look into outer and inner space as part of the African School of Fundamental Physics and Applications learner engagement programme.

A team of physicists and physics educators shared their knowledge with about 200 high school learners from Nelson Mandela Bay Metro in the first week of December.

The sessions were at Nelson Mandela University's Missionvale Campus in Gqeberha and the Nelson Mandela Bay Science and Technology Centre (NMBSTC) in Kariega.

QuarkNet educator Ken Cecire made sure there was no chance for any learner to be bored, with interactive activities and games that opened their outlook on the world of science.

In Kariega, learners were able to experience the workshop in the atmosphere of a modern science centre.

It also gave the facilitators the chance to try a few different ideas.

For example, the learners performed their own particle collision experiment using marbles, making a graph from the results.

At the NMBSTC, the scientists and the learners used foam blocks from an exhibit on construction to physically build their graph.

Cecire also bent a few young brains by explaining how each of them, individually, actually did bend space as they went about their daily lives.

The presenters' interests ranged from massive to miniature scale: Cameroon-born physicist Dr Esmeralda Yitamben works in the field of nanotechnology, which zooms in on the tiniest of particles, while Atteridgeville-born particle physicist Dr Gopolang Mohlabeng, who works at the University of California, is on a quest across galaxies in search of dark matter.

Most of the learners over the week-long programme were in grades 10-12, and their questions kept the ASP2022 crew on their toes.

"Can we travel in time?" asked 16-year-old Olwakhe Sentile, a grade 11 pupil at Ethembeni.

Although disappointed to learn that this was not (yet) possible, Olwakhe said she had learnt a lot from the session.

MARBLE MAGIC: Grade 10 learners, from left, Georgia Peffer, 16, Ciarah Williams, 16 and Carlin Smith, 15, learn about particles at Missionvale Campus. Picture:GILLIAN MCAINSH

Ethembeni Enrichment Centre pupils enjoyed the interactive science engagement at Missionvale Campus. Picture: MIKE SHEEHAN

"Maths and science got more intense in high school, and I thought I was a slow learner," she said.

"However, I knew what they were talking about today, and where they were going with the topics, and that gives me hope that I can learn."

Not all questions were strictly applicable to physics: one learner, confusing astrology and astronomy, asked the bemused scientists what they thought about zodiac signs.

Ethembeni Enrichment Centre grade 11 prefect, Lilitha Vena asked about the multiverse, exploring the idea that there are universes other than the one in which we live.

Sanctor grade 10 pupil Raynicia Ferndale, 15, said she had never experienced anything like the ASP2022 sessions before.

"Now I know that physics, geography and chemistry are all connected, and the presenters are inspiring me to chase my dreams."

One pupil posed this puzzler: "Who invented science and what were they thinking?"

This caused the facilitators to go back to the origins and nature of science to answer.

"It became an interesting discussion," said Cecire, adding that the facilitators were grateful for the interest and dedication shown by the learners.

The ASP aims to help improve higher education in Africa across national borders and, in doing so, to contribute in a significant way to the development of science and technology on the continent.

Its sessions also gave South African scholars the chance to see the diversity of careers — and personalities — to be found in physics, especially within the field of particle physics.

Back to the blackboard for high school science teachers

Gillian Mcainsh

High school teachers from across the Eastern Cape learned fresh facts about physics at the African School of Fundamental Physics and Applications (ASP2022) at Nelson Mandela University.

Working alongside national and international science educators, they developed their subject and presentation skills in a week of masterclasses, demonstrations and experiments.

The group of around 50 high school teachers, plus student teachers from Nelson Mandela University's Education Faculty, gathered on South Campus in Gqeberha from November 28 to December 2.

Presenters from the University of Notre Dame in the US and the University of Limpopo(UL) engaged with the teachers to boost their classroom confidence.

"Half of our physical science learners do not reach the 50% mark in their final exams," said UL lecturer Makonde Netsianda. "It is therefore vital to upskill teachers in this subject."

However, said his colleague Molamo Letsoalo, they also needed a solid understanding of mathematics.

"There is so much mathematics in science that teachers need to take a co-ordinated approach – the language of physics is mathematics," said Letsoalo.

Netsianda and Letsoalo acknowledged how lack of laboratory facilities and equipment made it different for learners to recognise concepts in practice outside the theory of their textbooks.

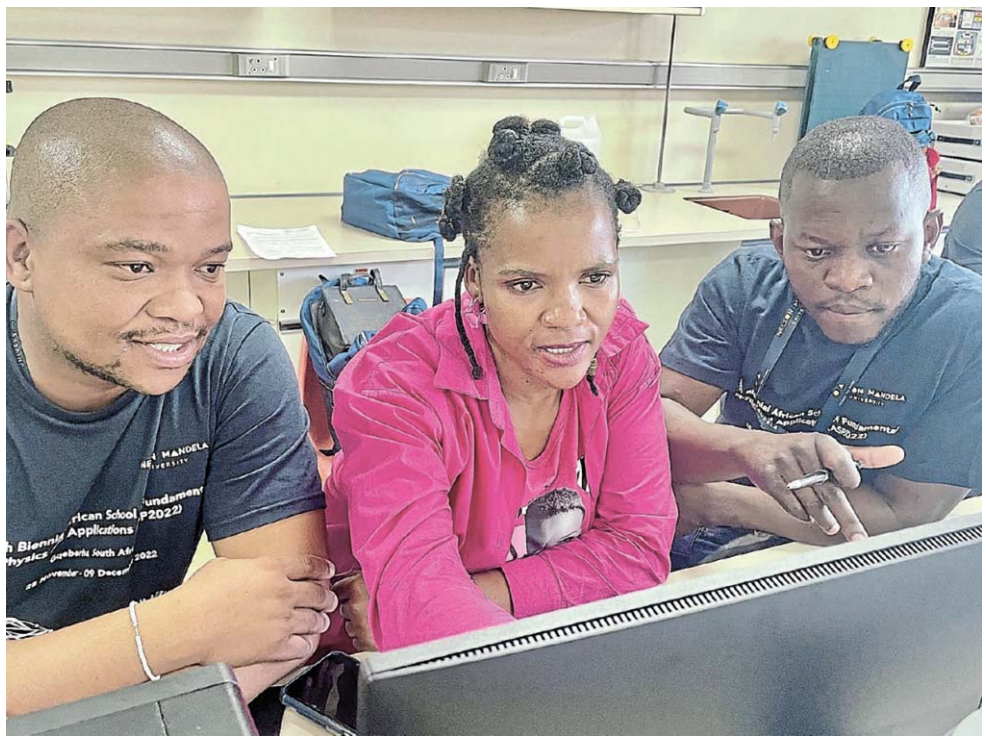
Zweliwelile Senior Secondary School teacher Noncedo Kwatshube, for example said the school, near Butterworth, had extremely limited resources for its 400 learners.

"I have 68 learners doing physical sciences in Grade 12 and, with this big proportion, that means the results of the school depend on the performance of the science department," she said.

"If the science department is doing well that means the whole school will perform.

"We need science apparatus to expose the learners to scientific methods such as experiments and practical work."

Science teacher Nikezwa Mahloko, from Mehlomakulu Senior Secondary School in Sterkspruit, said 80% of her learners were not performing well, with only 20% achieving the desired results.



High school teachers, from left, Mandilakhe Kula, Putuma Mpangele and Cwati Mlandeli get to grips with physics at ASP2022. Pictures: GILLIAN MCAINSH

Eastern Cape teachers, from left, Nikelzwa Mahloko, Noncedo Kwatshube and Scelo Khalishwayo were among the delegates at ASP2022. Picture: GILLIAN MCAINSH

"Our school does not have a laboratory, we don't even have a laboratory in the whole district, so it's not possible to do experiments. That causes our results to drop," she said.

"There is also a lack of textbooks, but we can't even make copies for the learners because of a shortage of toner and not enough papers.

"Most learners do not even have calculators."

Mount Fletcher educator Scelo Khalishwayo, from Luzie Drift Senior Secondary School, said due to lack of equipment he used YouTube videos to demonstrate scientific principles.

"The physics students do better than the maths students but we have challenges to improve the results," said Khalishwayo.

"The learners need to be able to visualise, and see practically, what you are presenting. They need to see what will happen."

He found the conference sessions extremely useful: "It has helped me a lot, I will go home with more information. We need this kind of workshop because it has been so productive."

Khalishwayo, Mahloko and Kwatshube echoed the views of their peers by asking for more input of this nature.

"More workshops should be conducted at the beginning of the year, or the start of each term," Mahloko said.

Kwatshube agreed: "Programmes like this should be done per semester as they help us as teachers to refresh our knowledge and improve our presentation or teaching skills. I learnt a lot from this programme."

University of Limpopo lecturer Makonde Netsianda illustrates free fall motion with a graph of acceleration versus time. Picture:GILLIAN MCAINSH

QuarkNet makes it easy to understand sub-atomic particles

Gillian Mcainsh

QuarkNet educators Ken Cecire and Shane Wood visited Nelson Mandela Bay to work with South African high school teachers and pupils, sharing experiences at the African School of Fundamental Physics and Applications held in November and December.

QuarkNet is a long-term, research-based teacher professional development programme in the US jointly funded by that country's National Science Foundation and its department of energy.

The University of Notre Dame (where Cecire and Wood are based), Fermilab and Lawrence Berkeley Lab started the programme to help high school pupils and teachers understand real-world particle physics research.

QuarkNet educators now travel to 50 centres around the US and collaborate with colleagues around the world. In Africa, they have conducted workshops in Kigali, Rwanda, and Addis Ababa, Ethiopia.

More recently, they were at Nelson Mandela University in Gqeberha for ASP2022, and Cecire was also involved with the international organising committee ahead of the school.

He said although there might be a perception that every school in the US had access to high-tech science laboratory equipment, there were still wide discrepancies in resources.

"Although I'm sure there are many differences, we've found a lot of commonalities," Cecire said of science education in the two countries.

"It's been an opportunity to compare experiences and talk through potential solutions. Overall we loved working with the students and educators, they are great people and we have had a lot of fun," Cecire said.

Wood said both countries' educational systems needed to answer the question: "What holes in understanding do students have that could have been dealt with at an earlier age?"

Some of the conversations that we're having here with teachers didn't sound dissimilar from those we have at home

Maths literacy, for example, was a problem facing educators in SA and the US, compounded when children did not get a firm grounding in earlier grades.

"You have students coming through a system that may not be efficient in preparing them for the next step in a subject.

"Teachers spend a lot of time doing review because the students never learnt it in the class before," Wood said.

Both countries, they said, also needed to improve inter-disciplinary communication between maths and science educators.

"We talked about some of the same issues we have in American education systems," Wood said.

"In some ways it was surprising but also reassuring to note there were similar struggles.

"Some of the conversations that we're having here with teachers didn't sound dissimilar from those we have at home.

"We both have this issue of students not being prepared for one reason or another!"

Whether it was discussing quarks over coffee, or dark matter during the lunch break, they said interactions outside the classroom were often unexpectedly rewarding.

"We didn't have a whole lot of time to get too into depth," Cecire said of these informal encounters.

"But getting together with teachers or physicists at an event like this you get into conversations, perhaps unplanned, but that really builds your overall perspective.

"Expanding perspective is always helpful."

Professor Peter Jenni

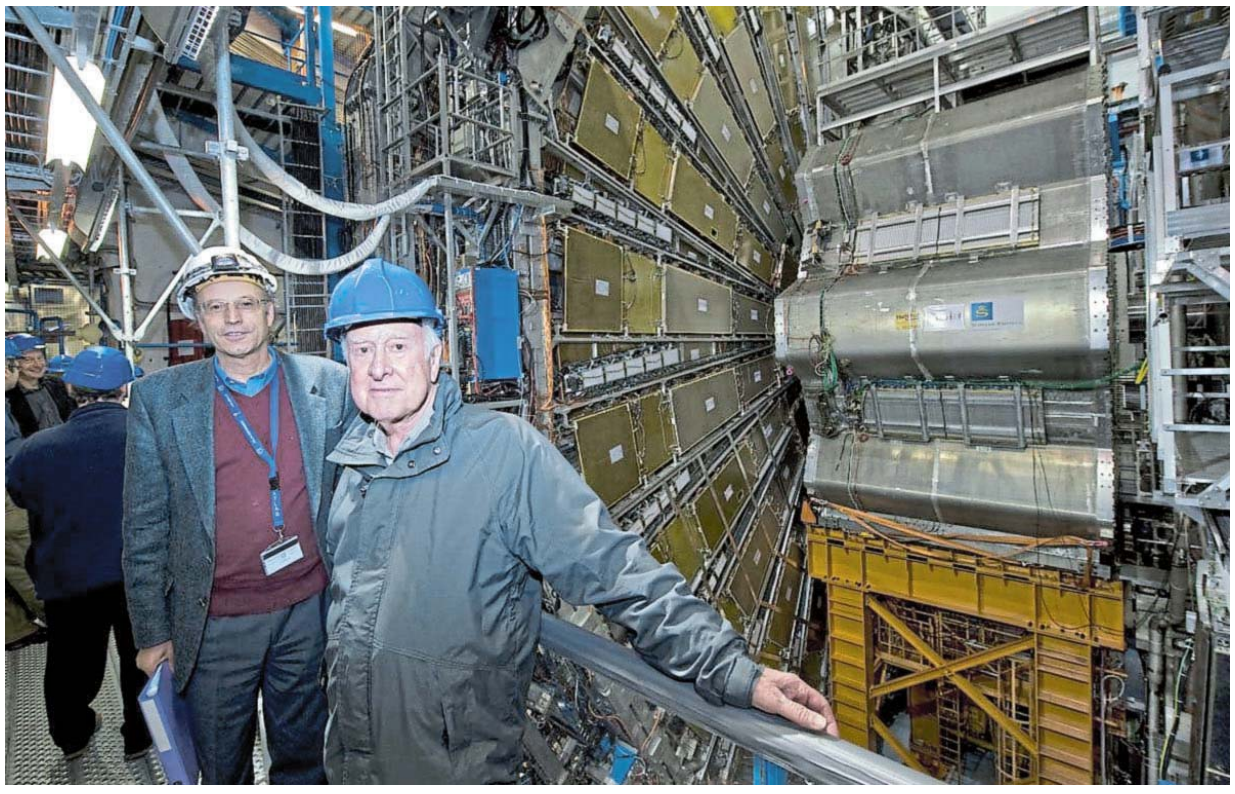
The long journey to the Higgs boson and beyond — the power of collaboration

Heather Dugmore

"Finding the Higgs boson at CERN's Large Hadron Collider (LHC) was all about the power of long-term research and collaboration in large science projects between large numbers of top physicists from many countries," said Professor Peter Jenni, an experimental physicist at CERN (the European Organisation for Nuclear Research) in Switzerland and the University of Freiburg (Germany) who gave a talk on the long journey to this discovery at ASP 2022.

"It was an absolute highlight in July 2012 when we were able to announce to the world the discovery of the long-awaited Higgs boson particle by the ATLAS and CMS teams," explains Prof Jenni who was the project leader of the ATLAS experiment at the CERN LHC until 2009 and is an ongoing collaborator.

ATLAS and CMS are the two general-purpose detectors at the LHC that look for new particles like the Higgs boson.



Professor Peter Higgs and Professor Peter Jenni at CERN in April 2008.

It was an absolute highlight in July 2012 when we were able to announce to the world the discovery of the long-awaited Higgs boson particle by the ATLAS and CMS teams

Could be a unique portal

Prof Jenni explains that the Higgs boson particle is fundamental to the understanding of the physical universe and nature in its smallest components.

Such is its importance that the media started referring to it as the 'God particle' but Prof Jenni does not like this term as he says this is about science, not religion.

Scientists believe it is the particle that gives all matter its mass and is a manifestation that the Higgs field exists. This could be a unique portal to finding signs of dark matter, thought to account for approximately 85% of the matter in the universe, making up most of the mass of galaxies and galaxy clusters.

"If we understand dark matter it would intellectually bring us a giant step forward as we don't really understand the evolution of the universe."

Worldwide collaboration of more than 3 000 physicists

The Higgs boson discovery came two decades after ATLAS started in 1992 and included a worldwide collaboration of more than 3 000 physicists from 183 institutions in 38 countries, including South Africa and a few other countries in Africa.

It took a huge amount of time to get to the first collisions in 2009 as the experiments at the LHC are the highest collision energies ever achieved in a laboratory.

"We gained experience from numerous smaller experiments over decades to build something of the unique size and complexity of the LHC, and develop very sophisticated software and analysis tools and methods that were required for the discovery," Prof Jenni explains.

In the course of these large science projects, apart from advancing human understanding about what makes life so special, scientists develop useful technology for the world.

The understanding of gravity, for example, was key to the development of the GPS, and the development of the world wide web is attributed to scientists working on colliders who needed to exchange information more than 30 years ago.

Beyond the LHC

Hadron colliders and their detectors are crucial to the success of the next step into the unknown.

A technical and financial feasibility study for a 100km circular collider at CERN with a collision energy of at least 100 TeV is now under way, as compared to 14 TeV with the LHC, but once again it takes time as there are tremendous technical challenges. "In the meantime we'll continue analysing more data from the LHC," says Prof Jenni.

MathArt competition promotes critical and creative thinking in schools

Nicky Willemse

To encourage pupils to bridge the gap between maths and art — and gain the skills they will need to navigate careers in the highly innovative and technologically creative Fourth Industrial Revolution — schools across SA have had the opportunity to participate in a MathArt competition, run annually since 2018.

The competition, run by Nelson Mandela University's Govan Mbeki Mathematics Development Centre (GMMDC), draws entries from every province — with many of the winning entries going on to be displayed overseas, through the international Bridges Organisation, a partner with GMMDC, and a supporter of the global shift towards STEAM education, an educational approach that uses science, technology, engineering, the arts and mathematics to encourage critical thinking among pupils.

Last year, the competition drew entries from 64 schools across eight provinces — and this year's competition, which kicks off in March, promises to draw even more.

Last year also saw the launch of a unique coffee table book, MathArt Expressions by South African Youth, which showcases a selection of the pupils' maths-inspired artworks collected over the years.

"In the book, we explore what we've done with the maths and art project and how we are working to promote the STEAM approach in teaching mathematics at school, in line with international trends," said GMMDC director Prof Werner Olivier. To further expand the STEAM approach in South African classrooms, GMMDC and their project partners from the University of Jyvaskyla, Finland, participated in the 2022 Southern African-Nordic Centre (SANORD) Annual Scientific Conference, held at the University of Limpopo in December.

"Delegates were impressed with the STEAM approach in schools to promote transdisciplinarity and Fourth Industrial Revolution skills among teachers and pupils," said Olivier.

In January, GMMDC and the Akademia University in Pretoria organised a STEAM education congress, themed "The advancement of inter- and transdisciplinary pedagogies of mathematics and science teaching in SA". The congress included talks by international STEAM expert Dr Kristof Fenyvesi from the Finnish Institute for Educational Research at the University of Jyvaskyla — who is also a GMMDC STEAM collaborator — and Prof Diego Lieban from the Federal Institute of Education, Science and Technology, Rio Grande do Sol in Brazil.

Staff at Nelson Mandela University's Govan Mbeki Mathematics Development Centre (from left) Flora Olivier, Victoria Shezi, Prof Werner Olivier and Carine Steyn have compiled a unique coffee table book showcasing learners' maths-inspired artworks.

GMMDC project collaborator Dr Kristof Fenyvesi from the Finnish Institute for Educational Research at the University of Jyvaskyla, Finland, hands a copy of the MathArt book to Anne Lammila, the Ambassador of Finland to South Africa.

Coding-without-computers project changing lives, communities and futures

Nicky Willemse

When Zwide youngster Culumanco Komanisi was introduced in grade 6 to TANKS — a programming app that doesn't need a computer — he didn't even know how to switch on a computer.

"I thought a computer was the smartest thing on this planet, but I was wrong," said Culumanco, now in grade 12. "Computers just follow human instructions."

Culumanco became hooked on programming — a passion that would lead to him getting a bursary to attend Alexander Road High, and also inspire a dream to complete his PhD in computer sciences one day.

"I developed computational thinking skills, actually understanding how the brain of a computer works."

Culumanco is one of nearly 100,000 pupils across SA, mostly from under-resourced schools, who have been introduced to the world of coding through TANKS and two similar coding-without-computer apps called RANGERS and BOATS.

But it is the dream of Prof Jean Greyling — the Nelson Mandela University computing sciences professor responsible for commercialising and rolling out these apps — to reach millions of pupils across Africa.

"We believe this is a solution from Africa for Africa ... That's why we have rebranded the project as 'Tangible Africa', in partnership with the Leva Foundation."

Prof Greyling's work forms part of a broader vision at Nelson Mandela University to make science exciting and accessible to more people, especially underserved communities, so they can be empowered with the skills needed to participate and thrive in today's modern world.

On Mandela Day last July, Prof Greyling led a continent-wide RANGERS competition that reached more than 6,000 children in 50 sites across several countries.

It was a project made possible thanks to global sponsor Amazon Web Services (AWS) InCommunities, national sponsors MiX Telematics and Transaction Junction, Gqeberha sponsors S4 Integration, and many others.

But this was not the first competition. During the lockdown days of Covid-19, Prof Greyling ran several virtual tournaments.

And early last year, Tangible Africa's "Coding 4 Youth" project saw 16,000 pupils in all nine provinces being introduced to coding.

Like Culumanco, some of the top-performing pupils have received scholarships for high school — and Prof Greyling is hoping even more sponsors will come forward.

"We are also finding bursaries for a few matriculants to study computer sciences ... To be making a difference in the futures and careers of young kids is unbelievable."

TANKS was first runner-up in the AU "Innovating Education in Africa" 2022 Awards, beating more than 900 applicants to be one of three organisations receiving grant funding and recognition for their innovative approach to education in Africa.

As a direct result, Tangible Africa is training country coordinators and master trainers in Ghana, Kenya and Zimbabwe — as well as Ireland.

In 2021, Tangible Africa was one of 10 winners in the international Falling Walls Science Breakthroughs of the Year.

And in 2019, it was chosen as one of 60 global projects presented at UNESCO's Mobile Learning Week in Paris, France.

Apart from changing pupils' lives, the project has upskilled about 20,000 teachers and equipped about 200 coding ambassadors — all unemployed youngsters — to introduce coding in schools, and assist with competitions.

Alexander Road High principal Matthew Ridgway (right) with Culumanco Komanisi (second from right), whose coding successes in primary school led to him receiving a bursary to attend the IT-strong school five years back, welcomes the newest coding bursary holders to grade 8 (from left) Norman Msaka and Rayhanah Walters. They received their bursaries from Amazon Web Services (AWS) vice-president and Mandela University alumnus, David Brown.

A group of pupils play TANKS under the watchful eye of Madiba on Mandela University's South Campus in Gqeberha.

Culumanco Komanisi, celebrates the project's successes with Mandela University computing sciences Prof Jean Greyling.

Maximising technology transfer for society

Heather Dugmore

It is important to create an ecosystem for scientists, engineers and inventors to adapt the deep technologies they develop for successful commercial ventures. This is a great way to maximise the potential of technology transfer for society.

Presenting on this at ASP2022 was Dr Farah Fahim, the co-convenor for Application and Industry for Snowmass. Snowmass is the Particle Physics Community Planning Exercise where the entire High Energy Physics community comes together to identify and document a vision for the future of particle physics in the U.S. and its international partners. This includes studying and creating recommendations to address both the science and community requirements of the field.

Dr Fahim is also a principal engineer and Division Head for Microelectronics at Fermi National Accelerator Laboratory (Fermilab) – the U.S.'s premier laboratory for particle physics and accelerator research, situated near Chicago and funded by the U.S. Department of Energy. Dr Fahim has a PhD in electrical and computing engineering. For the past 15 years she has focused on developing new technology in the form of low-noise, high-speed, reconfigurable pixel detectors, which operate in harsh environments, for a variety of applications including high-energy physics, photon science and space science. "At the same time, on a commercial level, we believe these pixel detectors can become the medical imaging technology for tomorrow, and venture capital firms are interested," she explains.

While pushing the technology bounds for physics, incredibly useful commercial applications have emerged over the decades, such as detectors for PET scans or magnets for MRI machines which were originally developed for high energy physics.

"There is huge potential for return on investment but most industries out there don't know what we are doing and what we can do; that we can, for example, be a partner and significantly contribute to advancing instrumentation for financial systems, medical imaging and other commercial technology products."

Dr Farah Fahim, a principal engineer at Fermilab, working on Cryogenic ASICs for Quantam.
Picture:FERMILAB

Dr Fahim adds that to accommodate deep technology commercialisation, there has to be a shift in the way national lab researchers are supported, along with adding funding programmes specifically aimed at deep technology transfer. At academic institutions, university professors are encouraged to start spin-offs and engage in technology commercialisation with no impact on their university research and teaching role. However at national labs, research and commercialisation is almost mutually exclusive for scientists and engineers. There is a hard transition that needs to be made from a researcher to an entrepreneur, with little or no mechanism to de-risk this process creating an undue burden and automatically excluding certain socio-economic backgrounds.

"At Snowmass we explored how we can improve this process and also study globally ways in which CERN (Switzerland), RIKEN and KEK (Japan) enable technology commercialization," explains Dr Fahim.

"The tech developed for particle physics is orders of magnitude more challenging and far outpaces the need for current commercial applications. Quantum computing today as an example is facing the same but hugely elevated level of issues that classical computing faced 50 years ago, including how to solve the wiring and automation challenge, and how to compensate for drift. These scaling challenges are similar to those we encounter for deploying large high energy physics detectors."

For her research she collaborates extensively with industry "because everything we use in deep technology development at Fermilab has to be robust and reliable and it has to be commercially made. Therefore we need an ecosystem where industry supports physics and technology developed for physics gets utilised by industry."

On a commercial level, we believe these pixel detectors can become the medical imaging technology for tomorrow, and venture capital firms are interested

FameLab international winner takes indigenous knowledge to the world

A combination of creative flair, scientific prowess and keen interest in indigenous knowledge systems was what placed a Nelson Mandela University researcher and phytochemist at the helm of the biggest science communication competition in the world.

Dr Nehemiah Latolla's research into ways to treat diabetes using natural remedies saw the young poet and fashionista crowned as the overall winner of the FameLab International science communication competition in November.

Dr Latolla said winning the FameLab International Final 2022 came as both a surprise and reassurance of his chosen career path in science.

"Winning FameLab has come with many opportunities for personal growth and engagement in my scientific field," he said.

"I am both honoured and humbled by this great feat and hope to move on stronger from this, spreading the importance of communicating our science effectively with the communities we serve."

Since his announcement as overall winner, Dr Latolla has been interviewed across various media platforms where he has shared the essence of his work.

"It has come with so many opportunities, such as connecting with global and local publics on my research and the importance of African indigenous knowledge as solutions for our societal ills," he said.

"I've also had the opportunity to be invited as a guest speaker to various engagements including our recognition graduation sessions at Nelson Mandela University, and more recently as a guest speaker at the STEM Club Confestival 2023, hosted by the Cape Teaching and Learning Institute (CTLI) to engage STEM teachers on the importance of fun in science education."

Dr Latolla's research, hosted by Dr Buyiswa Hlangothi, evaluates the safety and efficacy of natural products to treat diabetes, which is the second leading cause of death due to disease in SA.

FameLab international winner Dr Nehemiah Latolla.

Science has tremendous potential to cause positive change for society and for the environment — but first it has to be shared

"SA has about 30,000 recorded plant species, of which approximately 3,000 have the potential for medicinal use.

"However, there is a lack in the reported chemistry, safety, and efficacy of these medicinal plants," he said at the time.

In the presentation that won him the international title, he shared the bittersweet memory of home care health, where he had to drink a mixture of Aloe Ferox in magnesium salt growing up.

"He said it was this experience that piqued his interest in the chemistry of plants.

"This has been an incredible journey, realised by sharing the indigenous knowledge systems of our country and their possibilities to address drug discovery," he said.

Dr Latolla, who is a postdoctoral researcher at Nelson Mandela University, is now doing research that seeks to explore new, cost-effective, less-toxic medication to treat diabetes.

FameLab is the biggest international competition that seeks out and supports science communication talent. This year marked the 10th season of the competition in SA, introduced to the country by Robert Inglis, who is the director of the science communication agency Jive Media Africa.

"For science to have positive effects on people's lives, it has to leave the laboratory," Inglis said.

"Science has tremendous potential to cause positive change for society and for the environment — but first it has to be shared.

"FameLab develops skills among young researchers to share their science with the world."

Rural partnerships boost maths and science

Professor Azwinndini Muronga
Executive Dean of Science Nelson Mandela University

Maths and science outreach with learners in Vhembe.

As higher education institutions we have to partner with schools to encourage more girl and boy learners to study maths and science. South African universities are not seeing sufficient enrolments in these subjects which are critical for research, innovation and the future of work.

Our rural schools in particular require our input to ensure they are not left behind. Partnering with them and with universities in the rural areas is entrenched in our Faculty of Science's science engagement strategy to increase the flow of students from all nine provinces and other African countries, particularly the SADC region.

Over the past few years, we have been increasing our maths and science engagement with schools and communities in our rural areas, starting with the Eastern Cape, KZN and Limpopo. We visit and host maths and science exhibitions, workshops and career expos.

In partnership with our Faculty of Education and professional bodies such as the South African Institute of Physics we also coordinate maths and science teacher development programmes to advance their skills in teaching these critical subjects.

Where there is higher education investment in basic education, from the foundation phase through to the FET phase, we see the results in the improved matric results. From here, we continue to nurture young scientific talent from the undergraduate to postgraduate levels.

Digitalisation greatly assists this, as when we hold forums or training sessions at Nelson Mandela University or at the Albertina Nontsikelolo Sisulu Science Centre in Cofimvaba, Eastern Cape, we make sure they are beamed to other centres where groups of learners and educators have gathered, such as at the Vuwani Science Centre in Vhembe, Limpopo, and the Nkomazi Mathematics and Science Centre in Mpumalanga.

We also do physical visits. In May 2022 our Faculty of Science undertook a four-day visit to several schools, communities and royal houses in the Vhembe District of Limpopo, as well as to the University of Venda where we are developing a partnership with their Faculty of Science. Year-on-year, some of the best maths and science students in the country are from the Vhembe district, and as a faculty we are scouting for rural talent. We do similar outreach in the Cofimvaba, Cala and Mvezo regions of the Eastern Cape, and we are currently expanding our outreach to Mthatha and Graaff-Reinet in the Karoo.

Learners in the rural areas in general often do not have the knowledge they need about what programmes are available at the full range of South African universities and how to apply. When we go to their schools we know we are changing the course of history because suddenly learners have insight as to which subjects and career paths they can pursue, and what they need to achieve marks-wise to achieve access to university.

NITheCS students share their experience of the programme

While many of their peers were enjoying the end-of-year summer break from academia, National Institute for Theoretical and Computational Sciences (NITheCS) interns shared how their passion for scientific study and exposure to various aspects of science made their experience worthwhile.

Sinegugu Mthembu, who is an alumnus of the programme and now a tutor, said she was initially exposed to the programme in 2017, when she was gearing up to begin her honours studies in physics.

"The topic then was 'Compact Stars' and the exposure encouraged and enabled me to pursue my masters, and I'm now doing my PhD in nuclear physics.

"I was fascinated by the early universe and never really realised just how much there was to learn," she said.

"The more I learnt, the more I wanted to learn, which is what influenced my decision to re-join the programme as a tutor.

"When I started the programme, there were only nine of us, and Prof Muronga was the only one tutoring, so it was an honour to get an opportunity to assist."

Mthembu, who grew up in rural KwaZulu-Natal, said she pursued studies in science to understand "how and why things are the way that they are."

From having wanted to pursue a career in acting after matriculating in 2012, Capetonian Ron-Ryan Baatjies's rerouting to science was, interestingly, inspired by the bible verse "God created the universe".

Baatjies, who hails from Delft township on the outskirts of the city, is doing his honours in astrophysics and space science as part of the DSI-NRF funded multi-institutional initiative aimed at training SA students in astrophysics and space science at honours and master's levels and providing a pipeline to PhD studies in these and related research areas.

"Being part of this programme has been quite an experience; gruelling, yet very exciting and fun," he said.

"The first two weeks [when the interns were part of the African School of Physics (ASP2022)] were intense, but thereafter we started working on the early universe projects and trying to understand what happened after the Big Bang and the overall expansion of the universe."

It was an amazing experience to be in the room and hear directly from some of the people whose work and theories I've read, such as Prof Muronga himself

Baatjies, who had a very modest upbringing, highlighted how one of the benefits of being part of the NITheCS internship was networking and creating rapport with other students and scientists from all over the country who share a similar passion.

"Before coming to Gqeberha for the programme, I had never travelled out of Cape Town.

"So this has been an experience of firsts, and the exposure to various areas of science definitely opened a whole new world for me," he said.

"I look forward to doing a masters' in cosmology, and going on to do a PhD — hopefully overseas, coming back to SA thereafter."

For Busani Bhengu, who is now doing his masters in nuclear physics, the programme was an eye opener, as he got to hear from scientists whose work he'd only ever read.

"I read a lot of books on various topics, but especially science.

"It was an amazing experience to be in the room and hear directly from some of the people whose work and theories I've read, such as Prof Muronga himself.

"Being able to engage with them directly and unpacking some of their theories was everything," he said.

"I really wish I'd been exposed to this programme much earlier."

From Quarks to the Cosmos

For the past six years the National Institute for Theoretical and Computational Sciences (NITheCS) Internship Programme has been hosted annually by Nelson Mandela University's Faculty of Science, led by the Executive Dean of Science, Professor Azwinndini Muronga in partnership with NITheCS. During the COVID-19 pandemic it was held online. Physical attendance resumed in 2022.

The NITheCS 2022/23 saw 50 final year BSc and postgraduate students from universities throughout South Africa participating in the internship programme at Nelson Mandela University's Faculty of Science from 28 November to 23 December 2022. The programme continues online until June 2023. The majority of interns are from historically black universities, especially the rural universities. In December 2022 the NITheCS 2022/23 overlapped with the ASP2022 to give NITheCS interns the benefit of attending lectures by international experts.

"The internship is all about preparing final year BSc, honours and master's students from all South African universities to be high-level problem solvers. It equips them to be in demand in a wide range of employment sectors or to pursue further research," says Professor Muronga who, over the past 12 years, has annually given of his time to host and facilitate the group, assisted by tutors (mainly postgraduate students and postdoctoral researchers).

"Physics is the basic science underpinning all sciences, engineering and technology and during the internship they study the properties of matter that make up the universe – from the smallest to the largest – from quarks to the cosmos – and how to connect physics knowledge between the two extremes."

Names for a new era in science education

SHINING A LIGHT: Nelson Mandela University's new science building has been renamed Inkanyezi which means star.

Nelson Mandela University has a naming and renaming programme that symbolically signals a commitment to transformation in naming places, spaces and buildings that enhance the Mandela name while entrenching the University's intellectual identity.

As part of this programme, the Faculty of Science has renamed three of its buildings on South Campus as follows:

Mvezo

Nelson Mandela was born in the small village of Mvezo, not far from Mthatha in the Eastern Cape. The Faculty has a long-standing relationship with this community of Mvezo, having hosted science week and other "science for society" engagements here.

Renaming building 12 to Mvezo is a nod to this ongoing relationship.

It houses several faculty academic departments and entities.

Katherine Johnson

Various academic departments and entities within the faculty use this building, formerly known as building 13.

Today it is named after African-American mathematician Katherine Johnson (1918-2020), whose work was integral to the success of Nasa's space flights.

Choosing the name of an inspirational woman scientist who was previously relatively unrecognised sends a message of encouragement to the girl child, and others who have been "hidden figures" to pursue, and excel in, STEM fields.

Inkanyezi

Building 127, informally known as the new science building, has been renamed Inkanyezi, "star" in more than one Nguni language.

Inkanyezi is the Faculty's administration hub and contains lecture and laboratory venues.

It has hosted international conferences and, as a "star", it shines a light to call together academics and the community and guide them forward.