THE WORLD ACADEMY OF SCIENCES
for the advancement of science in developing countries

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# The importance of basic sciences for sustainable development

## A perspective from the global South

NWO Physics
Session on Basic Science for Sustainable Development
4 April 2023

**Romain Murenzi, Executive Director**

The World Academy of Sciences

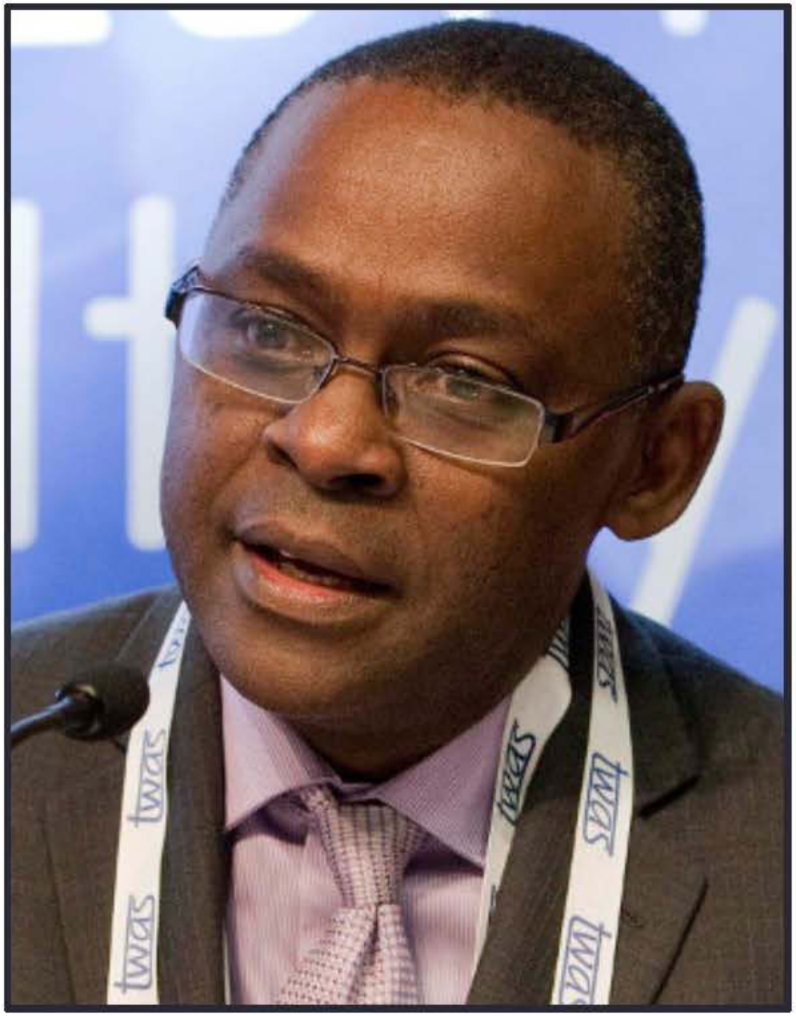
for the advancement of science in developing countries (TWAS)

# Romain Murenzi

Former Minister of Education, Science, Technology and Scientific Research, and Minister of Science, Technology and Information and Communication Technologies, Rwanda.

**Former Director, AAAS Center for Science, Technology and Sustainable Development.**

Currently: Executive Director, TWAS, The World Academy of Science



# Sustainable Development and Science

TWAS was founded by a physicist: The Pakistani Nobel laureate **Abdus Salam**. His contributions to theoretical physics set the foundation for standard model for modern particle physics. He also believed that science belonged to all of humanity, and should serve to fulfil people's basic needs.

***"With man's recent mastery of science and technology there is no physical reason left for the existence of hunger and want for any part of the human race."***

**– Abdus Salam (1963)**

# Challenges:
## Sustainable Development

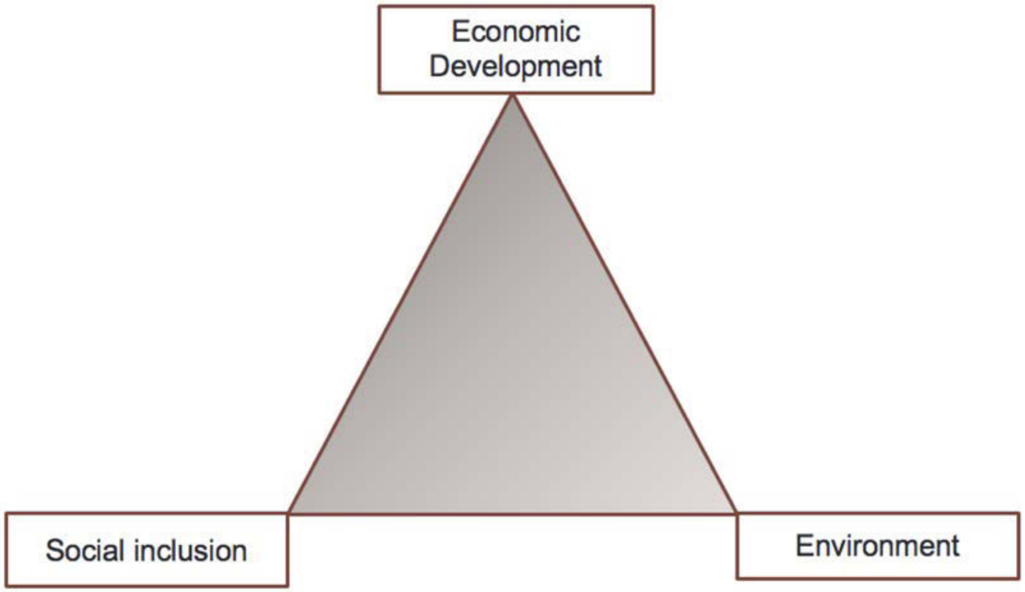
# History of sustainable development


Then WCED chair and Norwegian Prime Minister Gro Harlem Brundtland

**The Brundtland Report** (also called "Our Common Future") by the World Commission on Environment and Development (WCED), and sponsored by the UN, introduced the concept of **sustainable development** and examined how it could be achieved.

# Challenges:
## Sustainable Development

# What is sustainable development?




Development that meets the needs of the present without compromising the ability of future generations to meet their own needs. Sustainable development calls for concerted efforts towards building an **inclusive**, **sustainable** and **resilient future** for people and planet.

# **Challenges:**
## Sustainable Development

## Sustainable development today

- In 2015, the global community transitioned from one development agenda, the **Millennium Development Goals**, to another, the **Sustainable Development Goals**, which will run to 2030.

- Need to have a close link between development and sustainability.

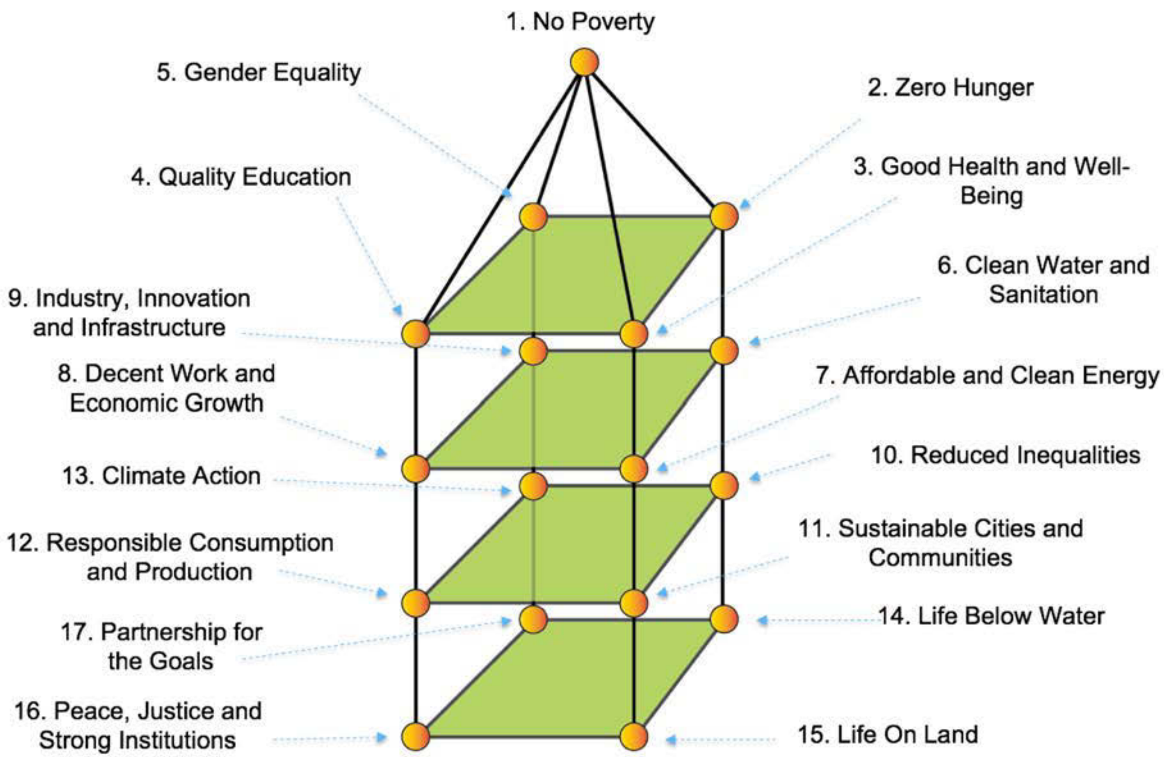
- Need to take the livelihood of future generations into account in the development agenda.

# Challenges:
## Sustainable Development


The **SDGs** are the international community's most ambitious effort ever to resolve the world's greatest challenges and set a firm course for sustainable global development.

It is no exaggeration to say that the new goals could shape **humanity's future** for the next century, or more.

# Challenges:
## Sustainable Development




The goals serve as a framework for global research and funding until 2030 and beyond. The stakes for humanity are high, and scientists and their allies must make sure that efforts to achieve the goals are shaped by **strong research and data**.

And **basic sciences**, including **physics**, play an essential part in this project.

# **Challenges:**
# Sustainable Development


UNESCO named 2022 the **International Year of Basic Sciences for Sustainable Development**, with celebrations running from 2022 to 2023.

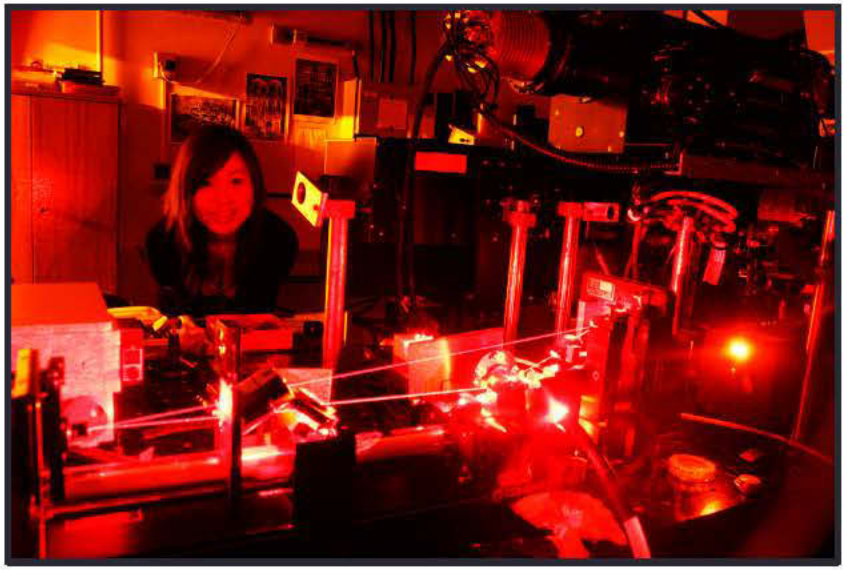
*“Agenda 2030 for Sustainable Development is the ambitious program that the Member States of the United Nations have agreed on to ensure a balanced, sustainable and inclusive development of the planet.* ***Basic sciences*** *have an important contribution to make to the implementation of this program. They provide the essential means to meet crucial challenges such as universal access to food, energy, health coverage and communication technologies.”*

—**Michel Spiro,** President of International Union of Pure and Applied Physics

# Challenges:
## The Fourth Industrial Revolution

We are entering a new era of knowledge, as the automation of the Fourth Industrial Revolution will lead to an increasing number of jobs that require education in complex fields such as:

- **Artificial Intelligence**
- **advanced robotics**
- **biotechnology**
- **new materials**
- **autonomous vehicles**



# **Challenges:**
# The Fourth Industrial Revolution

*"The First Industrial Revolution used water and steam power to mechanize production. The Second used electric power to create mass production. The Third used electronics and information technology to automate production. Now a Fourth Industrial Revolution is building on the Third,* ***the digital revolution that has been occurring since the middle of the last century****. It is characterized by a fusion of technologies that is blurring the lines between the physical, digital, and biological spheres."*

--Klaus Schwab, Founder and Executive Chairman,
of the World Economic Forum,
in *Foreign Affairs*, 2015

# Challenges:
## The Fourth Industrial Revolution

23 February 2023

TWAS IN ACTION

### TWAS graduates its 1,000th PhD

Aakash Kumar of Pakistan, who is researching artificial intelligence in China, received a doctoral degree that is also an historic milestone for the TWAS fellowship programme


Aakash Kumar of Pakistan, who is researching artificial intelligence in China, is the TWAS Fellowship Programme's 1,000th PhD graduate. [Photo provided]

TWAS PhD fellowships have been building scientific strength in the developing world by training new scientists since 2004. And now, the programme has reached a remarkable milestone, graduating over 1,000 PhDs.

The 1,000$^{th}$ PhD graduate is Aakash Kumar, who left his home country of Pakistan in 2017 to pursue doctoral studies at the University of Science and Technology of China (USTC) in Hefei, China. "I wanted to do bigger things in my life, so I decided to apply for a scholarship," he said.

Recently, we at TWAS celebrated a special occasion, our 1,000$^{th}$ PhD graduate! The graduate, Aakash Kumar, happens to be a Pakistani scientist conducting artificial intelligence research in Hefei, China.

**Developing countries can help each other prepare for the Fourth Industrial Revolution.**

# Challenges:
## Capacity Building and Education Delivery

A major focus of TWAS is **capacity building**. By providing training and education to promising developing world scholars, we provide developing countries with greater expertise. This, in turn, increases the **capacity** of higher education and research institutions in the these countries to train and educate further scientists.

# Challenges:
## Capacity Building and Education Delivery

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**Basic sciences**, the study of nature out of curiosity, is an important element of this education! In order for students to discover and develop their latent talents, they must have the resources available to learn and the opportunity to discover new interests and pursue them.

# Challenges:
## Capacity Building and Education Delivery


**However...** this education is important at all levels. And the international community must be clear-eyed about an important fact: Education in the global South has faced a serious setback due to the COVID-19 pandemic.

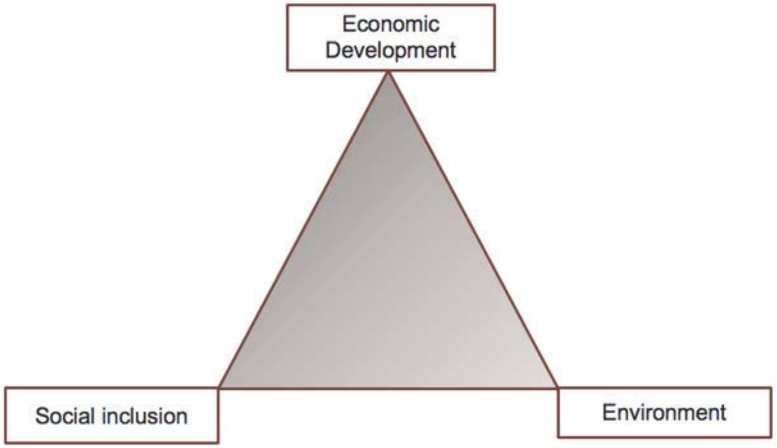
# Challenges:
## Capacity Building and Education Delivery

- The spread of the virus caught much of the world off-guard, causing a global crisis that disrupted all socio-economic structures, including health, education and transportation.
- Workforces were confined at home, putting in danger the livelihoods of billions.
- Education: many primary schools, secondary schools, and universities closed for a time. The nationwide school closures have impacted over 60% of the world's student population — with 1 billion learners affected with school closures in over 180 countries.

Source: UNESCO. 2020. "COVID-19 Impact on Education." https://en.unesco.org/covid19/educationresponse

# Challenges:
## Capacity Building and Education Delivery

- This period of disruption from COVID-19 laid bare inequalities in **access to education**, **scientific literacy**, deficiencies in **remote learning**, and the cost of the **digital divide**.




Source: Murenzi, et al. 2021. “Looking into Africa's Future: The Fourth Industrial Revolution and the Role of ICT Education”
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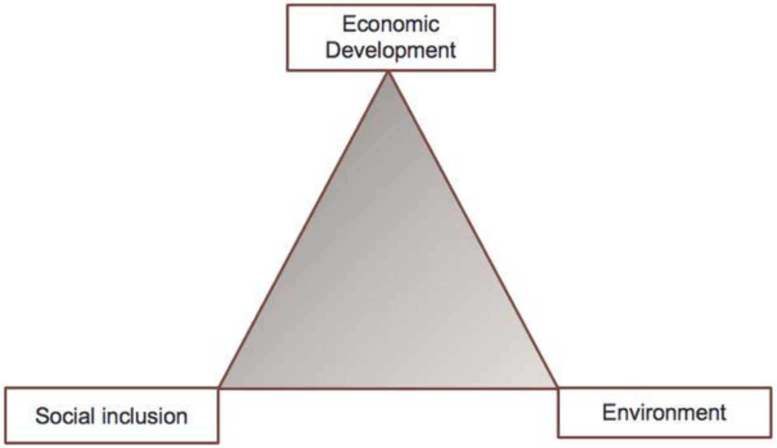


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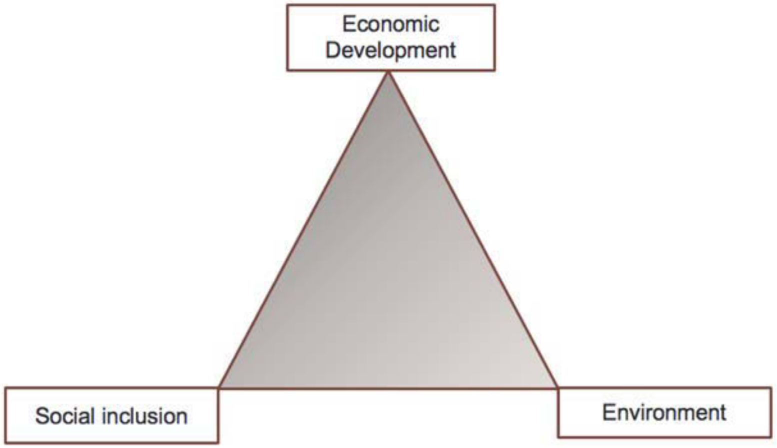


- The international community has yet to fully grasp the impact that this period of disruption in education will have in working towards the principle of **"leaving no one behind"**, a key tenet of the 2030 agenda for Sustainable Development.

Source: Murenzi, et al. 2021. "Looking into Africa's Future: The Fourth Industrial Revolution and the Role of ICT Education"
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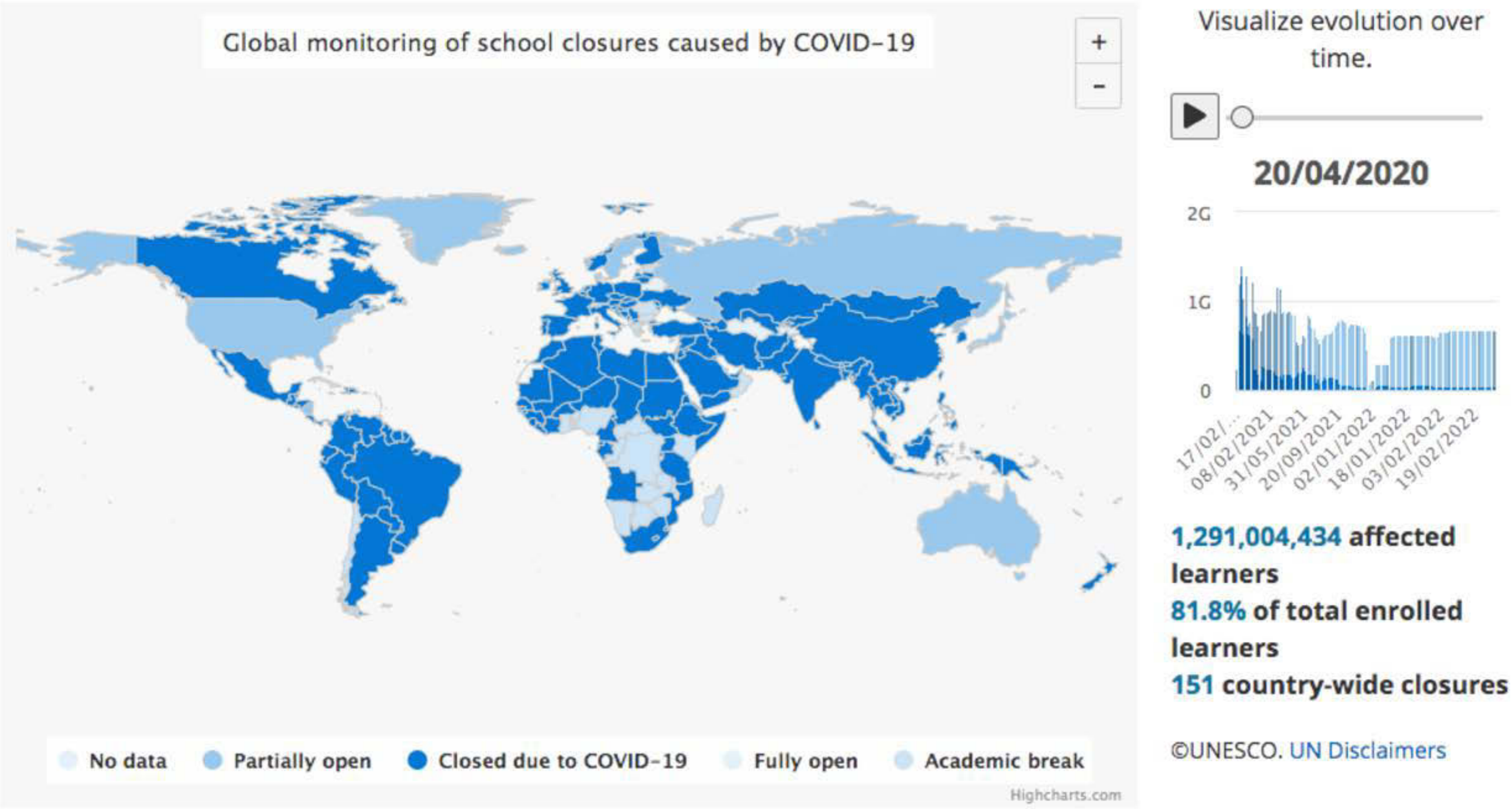
# Challenges:
## Capacity Building and Education Delivery

- **In the developed world:** most education was able to continue online thanks to access to information-technology infrastructure such as broadband connectivity at home and computer ownership.

- **In the developing world:** in most developing countries, and in Least Developed Countries in particular (33 of 47 LDCs are in Africa), this has not been the case.

# Challenges:
# Capacity Building and Education Delivery

At the **peak of the pandemic** in April 2020...




Source: UNESCO. 2020. “COVID-19 Impact on Education.”
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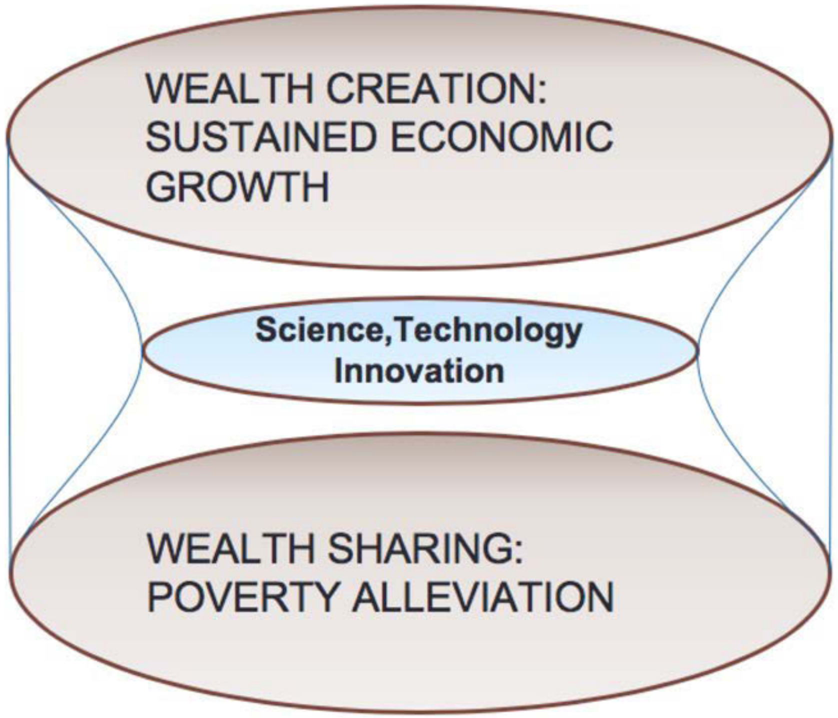
# Challenges:
## Capacity Building and Education Delivery

***Key question:** Why capacity building in science and technology?*

At the centre of local, national, and global politics you have two seemingly competing issues:

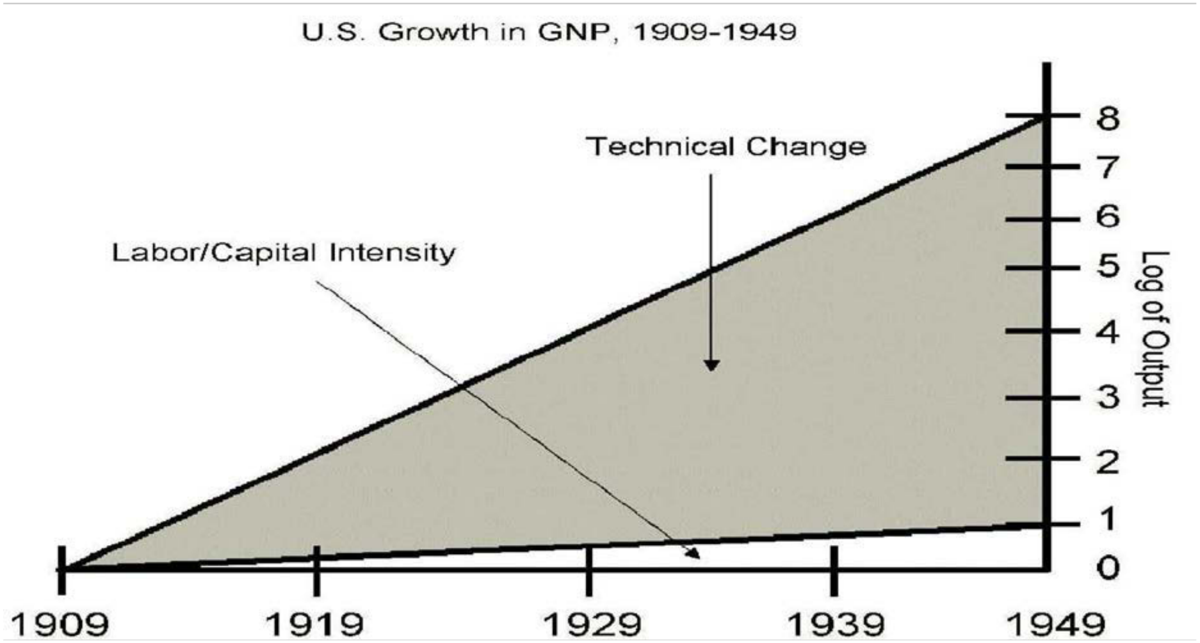



You can **not share** what you do not have. If the economy doesn't grow, there is no chance at all for reducing poverty or even just investing in social sectors such education and health.

# Challenges:
## Capacity Building and Education Delivery

**Economic Leadership:** Robert Solow, 1957: Sustained Economic Growth is Possible

**USA 1909-1949:**
87.5% of output attributed to the applications of science and technology, while capital alone without technology attributes a mere 12.5%.



# Challenges:
# Capacity Building and Education Delivery

## **Business Leadership:** Bill Gates: *"How to Keep America Competitive"* (*Washington Post*, 25 February 2007)

- "For centuries, people assumed that economic growth resulted from the interplay between capital and labor. Today we know that these elements are outweighed by a single critical factor: **innovation**."
- "**Innovation** is the source of U.S. economic leadership and the foundation for our competitiveness in the global economy."
- "Government investment in **research, strong intellectual property laws** and efficient capital markets are among the reasons that America has for decades been best at transforming new ideas into successful businesses."

# Example:
## Science for people in practice


As we examine the intersection of these challenges, I invite you to consider an example with me — Rwanda, where I served as the minister science and technology for several years under President Paul Kagame.

# Example:
## Science for people in practice

09/06/09

### Rwanda looks to S&T to speed development

*The Maraba Coffee Project has introduced coffee washing stations, like this one in Cyarumba Copyright: Wikimedia/SteveRwanda*

**By: Romain Murenzi**

**Science and technology minister *Professor Romain Murenzi* says science and technology will be at the heart of Rwanda's development strategies.**

Rwanda's recent history, which culminated in the genocide of 1994 and the deaths of up to one million people, also devastated the country's economy and infrastructure.

The country remains one of the poorest in the world, with 57 per cent of the population living on less than US$1 per day. Contributing factors include a high population growth (3 per cent) and density (310 people per square kilometre), and a predominately rural population (90 per cent) with no access to electricity and which relies strongly on agriculture (accounting for 47 per cent of GDP), much of it at a subsistence level.

Rwanda urgently needs to develop both economically and socially but its natural resource base is very low — virtually non-existent. Improving Rwanda's science, technology and innovation capability is essential for the country's development and will reduce its poverty.

**Looking ahead**

The Kagame government chose to ambitiously pursue development of science and technology development in an effort to improve its position, and its people lives, after the terrible genocide of 1994.

# Example:
## Science for people in practice

Paul Kagame, during a visit to the Royal Society, 19 September 2006:

**“We in Africa must either begin to build up our scientific and technological training capabilities or remain an impoverished appendage to the global economy.”**

# **Example:**
# Science for people in practice

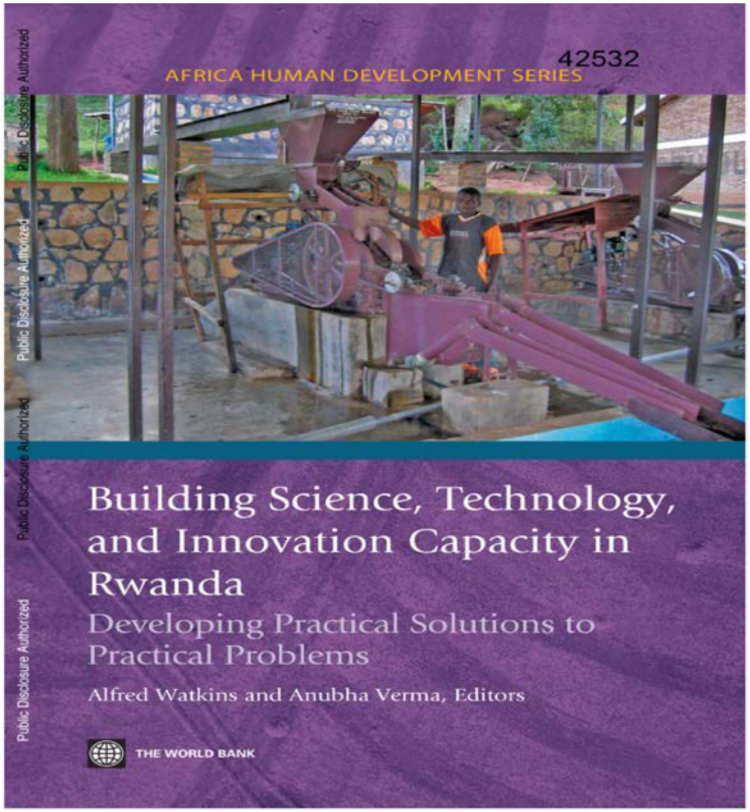
**Innovation, Intellectual Property, and Entrepreneurship:**

To encourage innovation at all levels to help stimulate economic growth.

- Primary innovations: low-level technologies at the grassroots level.
- Secondary innovations: mid-level technologies at the local industries.
- Tertiary innovations: physical, digital and biological systems.

# Example:
# Science for people in practice

Primary Innovation: **Maraba Coffee Washing Station (Rwanda)**



# Example:
## Science for people in practice

Secondary Innovation: **Silk (Rwanda)**

| Sector | Activity | Science and techniques |
|---|---|---|
| Agriculture | Cultivating high quality, disease-free mulberry crop | Agriculture Science and Agronomy: Crop Variety Improvement, Mulberry Pest Management, Soil Chemistry |
| Rural Development | Rearing disease-free, high quality silkworms | Sericulture Techniques: Drying, cooking, reeling, testing and grading cocoons |
| Rural Development | Reeling silk yarn from cocoon; Weaving yarn into raw silk | Sericulture Techniques: Silkworm Strains Management, Production of Quality Silkworm Eggs, testing and grading raw silk |
| Industry & Commerce | Designing/Manufacturing Silk Garments & Made-Ups | Textile Engineering, Garment Designing, Factory Operation and Maintenance |
| Trade & Exports | Meeting Market Demands and Standards of Quality and Style | Market Research, Quality Testing and Maintenance |

Investment and Business Climate
Private Sector Reforms

*Provided by Mike Hughes*

# Example:
# Science for people in practice

Tertiary Innovation: **Robotics to combat COVID-19 (Rwanda)**

- To minimize contact time with confirmed cases and therefore reduce the risk of contamination of health professionals in COVID-19 treatment centres, robots were deployed.
- The 5 human-size robots are programmed to perform temperature screening, take readings of vitals, deliver video messages and detect people not wearing masks then instruct them to wear masks properly.
- Named in Kinyarwanda: Akazuba, Ikirezi, Mwiza, Ngabo, and Urumuri are made by Zora Bots, a Belgian company specialised in robotics.
- Urumuri was deployed at the Kigali International Airport with the capacity to screen 50 to 150 people per minute and report abnormalities to officers on duty.


https://www.afro.who.int/news/robots-use-rwanda-fight-against-covid-19

(***Provided by Mike Hughes***)

# Challenges:
## Digital Literacy and Science Literacy

The effects of COVID-19 on the educational system, the advent of the Fourth Industrial Revolution, and the Sustainable Development Goals imperatives, require us to **reimagine education**.

We must ensure that our renewed education system is: flexible, equitable, and inclusive. Physical and distance education will need to cohabite.

# Challenges:
# Digital Literacy and Science Literacy

## The question of access

***Access to computers:*** Computers allow access to educational materials such as books and downloaded lessons, as well as provide a tool through which to follow classes through internet.

***Access to broadband Internet:*** The Internet is resilient mode of education delivery. Use of the Internet, in time, will become obligatory. A situation will emerge where there is no alternative.

***Access to electricity:*** The continued access to electricity, both at home and in schools, is essential to be all of the above.

# **Challenges:**
# Digital Literacy and Science Literacy

## Coding

- School systems need to help students adapt to rapid **changes in the workplace** and other effects of rapid digitization, from ethical standards and cybersecurity to the impact on health, forensics, and many other parts of the economy.
- In the digital era, educators need to expand their understanding of what it means to **be literate in the 21st century**: not replacing traditional learning but complementing it.
- **Computer programming** and **digital literacy** are becoming core skills.
- For example, England **has integrated computer science** into all levels of primary and secondary education, so students start learning about coding and internet safety from age 5.

# **Challenges:**
# Digital Literacy and Science Literacy

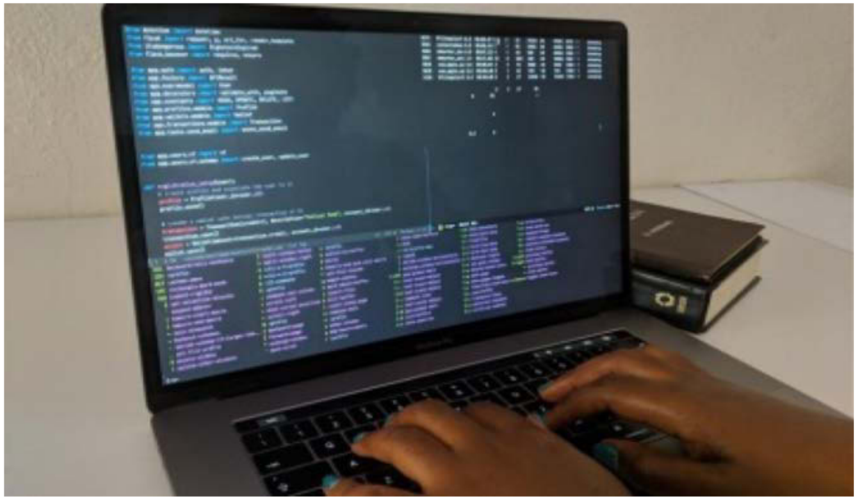
## Coding (in the U.K.)

- High-quality computing education equips pupils to use **computational thinking** and **creativity** to understand and change the world.
- Computing has deep links with **mathematics, science and design and technology,** and provides insights into both natural and artificial systems.
- The core of computing is **computer science**, in which pupils are taught the principles of information and computation, how digital systems work and how to put this knowledge to use through programming.
- Computing also ensures that pupils become **digitally literate** – able to use, and express themselves and develop their ideas through, **information and communication technology** – at a level suitable for the future workplace and as active participants in a digital world.

# Challenges:
# Digital Literacy and Science Literacy

## Example: Coding Academy in Rwanda

The Rwanda coding academy's vision is to produce excellence in software engineering workforce development. Its mission is to train young talented and gifted Rwandans in software programming, promote quality and excellence in coding skills and to position Rwanda as a software development hub.



# The contribution of TWAS

TWAS, **a global science academy** founded in 1983 in Trieste, Italy, supports sustainable prosperity through **research, education, policy, and diplomacy**. With its partners, it grows **scientific capacity** in the global South. TWAS is a programme unit of UNESCO.

# The contribution of TWAS

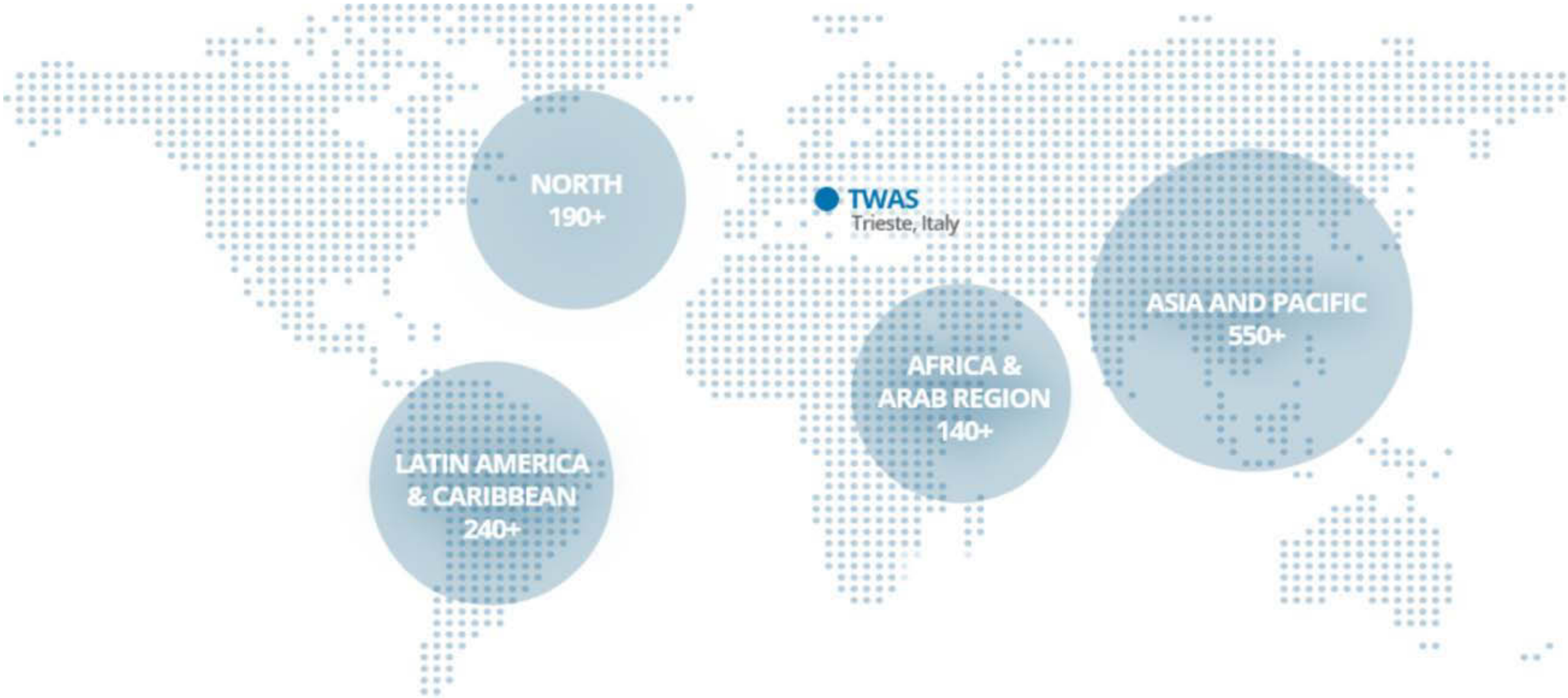
## The TWAS mission:

- Recognize, support and promote **excellence in scientific research** in the developing world.
- Respond to the **needs of young scientists** in countries that are still developing in science and technology.
- Promote **South-South** and **South-North cooperation** in science, technology and innovation.
- Encourage scientific research and sharing of experiences in **solving major challenges facing developing countries**.

# The contribution of TWAS

- TWAS has **graduated over 1,000 PhDs** and offered hundreds **of postdoctoral fellowships** to developing world scientists.
- TWAS also hosts some of prestigious **scientific awards**, has offered **research grants**, and supports **exchange visits** for scientists.

# The contribution of TWAS




TWAS Fellows are leading scientists who either live and work in the developing world, or make scientific contributions that are critical developing countries. Today, of the Academy's total membership of 1,384 TWAS Fellows, **284 are in the field of physics, astronomy and space sciences — and 31 of them are women.**

# The contribution of TWAS

Since its founding, TWAS programmes have provided valuable resources, such as training and funding, to scientists throughout the developing world.

- Total number of TWAS PhD graduates: **1,060+**
- Total number of total PhD fellowships awarded: **2,800+**
- Total number of TWAS postdoc fellowships: **450+**
- Total number of TWAS research grants: **2,760+**

# The contribution of TWAS

Since its founding, TWAS programmes have provided valuable resources, such as training and funding, to scientists throughout the developing world.

A substantive share of these awards go to **physicists in developing countries**.

- Total number of TWAS PhD graduates: **1,060+**
  Number in physics: **85**
- Total number of total PhD fellowships awarded: **2,800+**
  To physicists: **240**, contributing to **220+ publications**
- Total number of postdoc fellowships awarded: **450+**
  To physicists: **64**, contributing to **90+ publications**
- Total number of TWAS research grants: **2,760+**
  To physicists: **432**

# The contribution of TWAS

A few examples of TWAS grantees for research in physics...

**Dr. Nana Ama Browne Klutse (Ghana) -** Project title: Climate effect on food security: space technology for precision agriculture

**Dr. Souleymane Sanogo (Mali) -** Project title: Evaluation the Alternate Wetting and Drying approach for water saving in rice production and climate change mitigation in Mali

# TWAS and sustainable development

TWAS has been a long-standing advocate for basic science, sustainable development, and that science should be for all people — all of these priorities are deeply intertwined.

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EDITORIAL

## SCIENCE FOR ALL PEOPLE

▲ Romain Murenzi

Fifteen years ago, as the Millennium Development Goals (MDGs) were coming into focus, few could have imagined how they would help to change the world. Brazil, China, India and other nations were only beginning to emerge as centres of research and innovation. My own country of birth, Rwanda, was struggling to overcome the devastation of genocide. After making historic progress, these nations and others have emerged as models of possibility and hope for other developing countries.

With the MDGs expiring next year, the world is joining in a process to give shape to the post-2015 Sustainable Development Goals (SDGs). The draft list of goals touches on every major challenge confronting humanity: Food production and clean water. Health. Building stronger, more sustainable cities. Climate change and a range of environmental threats.

TWAS has joined in this process, and yet, we are aware that international organizations alone cannot solve these problems. If, for example, agricultural production is our goal, we are talking about a challenge that differs across continents, from region to region, sometimes village to village. Therefore, we should see the Sustainable Development Goals as a *global* framework for action that can be adapted by policymakers, educators, businesses, scientists and others at *local* levels.

As an overarching priority, the SDGs should advocate development of an effective and efficient innovation ecosystem that can support sustainable development far into the future. That involves policy and law, technology transfer, communication and partner networks. It will require science diplomacy.

Perhaps most important, building an innovation ecosystem requires education, from early childhood through PhD study. The MDGs have had a strong focus on primary education, and that's important. But when children advance through primary school and high school, are there excellent universities with strong professors awaiting them? Do these universities have modern laboratories and the latest information and communications technology (ICT)?

A nation with a weak corps of PhD scientists, ill-equipped laboratories and limited ICT will struggle to address its challenges. At TWAS, these issues are central to our mission. With our partners, we provide more than 300 fellowships every year to early-career scientists who want to obtain their PhDs. We provide about USD1.5 million each year in small research grants. These lessons can be applied to the post-2015 development agenda.

We must also consider the importance of science literacy in the wider society. If people do not understand the basic science of germs, they will be less likely to wash their hands. If a community does not understand the cause and impact of climate change, its people will be less likely to take remedial action.

The question, then, is how to enable communities and nations to build a culture of science that imparts strength and resilience. This question is at the heart of a debate now underway about the role of science in the SDG process.

Science is crucial in addressing the great challenges of our time and for developing the innovation ecosystem, and the SDGs will influence donor and funding decisions in the years ahead. Therefore, shouldn't the goals expressly support science literacy for every nation and every community? Shouldn't they advocate "Science for All People"?

**Romain Murenzi**, *TWAS executive director*

*This editorial is an abridged version of the presentation by TWAS Executive Director Romain Murenzi at the 17th Session of the United Nations Commission on Science and Technology for Development in Geneva, Switzerland.*

2 TWAS Newsletter, Vol. 26 No. 1, 2014

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— "Science for All People",
TWAS Newsletter editorial, 2014

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**Romain Murenzi**, *TWAS executive director*

*This editorial is an abridged version of the presentation by TWAS Executive Director Romain Murenzi at the 17th Session of the United Nations Commission on Science and Technology for Development in Geneva, Switzerland.*

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— "Science for All People",
TWAS Newsletter editorial, 2014

# TWAS and sustainable development

TWAS has been a long-standing advocate for basic science, sustainable development, and that science should be for all people — all of these priorities are deeply intertwined.

EDITORIAL

## SCIENCE FOR ALL PEOPLE

▲ Romain Murenzi

Fifteen years ago, as the Millennium Development Goals (MDGs) were coming into focus, few could have imagined how they would help to change the world. Brazil, China, India and other nations were only beginning to emerge as centres of research and innovation. My own country of birth, Rwanda, was struggling to overcome the devastation of genocide. After making historic progress, these nations and others have emerged as models of possibility and hope for other developing countries.

With the MDGs expiring next year, the world is joining in a process to give shape to the post-2015 Sustainable Development Goals (SDGs). The draft list of goals touches on every major challenge confronting humanity: Food production and clean water. Health. Building stronger, more sustainable cities. Climate change and a range of environmental threats.

TWAS has joined in this process, and yet, we are aware that international organizations alone cannot solve these problems. If, for example, agricultural production is our goal, we are talking about a challenge that differs across continents, from region to region, sometimes village to village. Therefore, we should see the Sustainable Development Goals as a *global* framework for action that can be adapted by policymakers, educators, businesses, scientists and others at *local* levels.

As an overarching priority, the SDGs should advocate development of an effective and efficient innovation ecosystem that can support sustainable development far into the future. That involves policy and law, technology transfer, communication and partner networks. It will require science diplomacy.

Perhaps most important, building an innovation ecosystem requires education, from early childhood through PhD study. The MDGs have had a strong focus on primary education, and that's important. But when children advance through primary school and high school, are there excellent universities with strong professors awaiting them? Do these universities have modern laboratories and the latest information and communications technology (ICT)?

A nation with a weak corps of PhD scientists, ill-equipped laboratories and limited ICT will struggle to address its challenges. At TWAS, these issues are central to our mission. With our partners, we provide more than 300 fellowships every year to early-career scientists who want to obtain their PhDs. We provide about USD1.5 million each year in small research grants. These lessons can be applied to the post-2015 development agenda.

We must also consider the importance of science literacy in the wider society. If people do not understand the basic science of germs, they will be less likely to wash their hands. If a community does not understand the cause and impact of climate change, its people will be less likely to take remedial action.

The question, then, is how to enable communities and nations to build a culture of science that imparts strength and resilience. This question is at the heart of a debate now underway about the role of science in the SDG process.

Science is crucial in addressing the great challenges of our time and for developing the innovation ecosystem, and the SDGs will influence donor and funding decisions in the years ahead. Therefore, shouldn't the goals expressly support science literacy for every nation and every community? Shouldn't they advocate "Science for All People"?

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# *Conclusions*

- **It is imperative** to invest in science education, and increase ICT infrastructure for young people — including robust investments in the Basic Sciences.

- **It is imperative** to increase digital and science literacy for citizens, to provide for a strong STEM workforce and ensure that people everywhere are able to participate in the Fourth Industrial Revolution.

- **It is imperative** to recognize that equitable access to science and technology is humanity's best chance for a future in which our shared resources contribute to common prosperity in a sustainable manner.

United Nations Educational, Scientific and Cultural Organization

The World Academy of Sciences
*for the advancement of science in developing countries*


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Thank you for your kind attention!

I now welcome any questions you might have.