THE WORLD BANK
IBRD • IDA | WORLD BANK GROUP

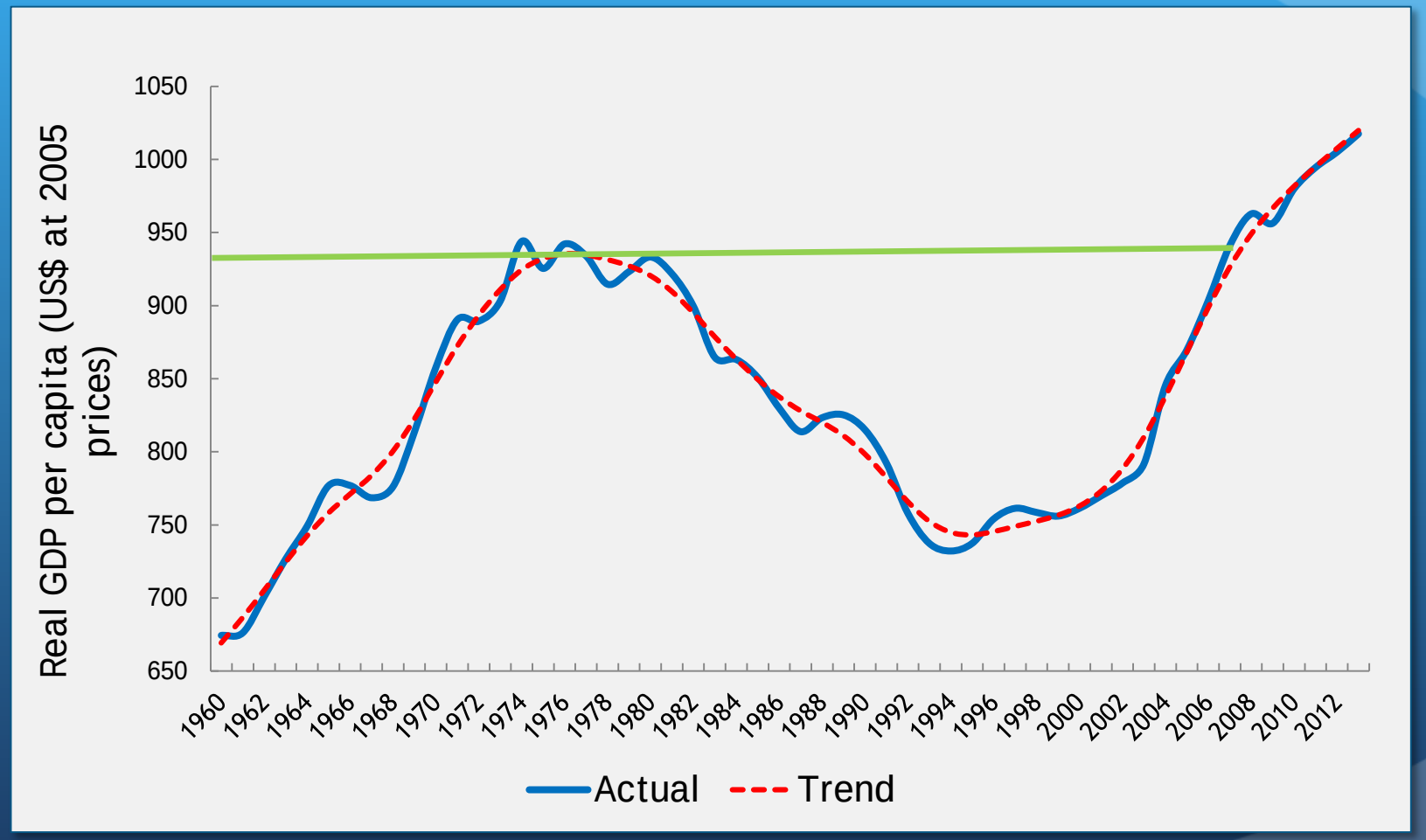
Mathematics and Science Education in Africa's Transformation

Sajitha Bashir

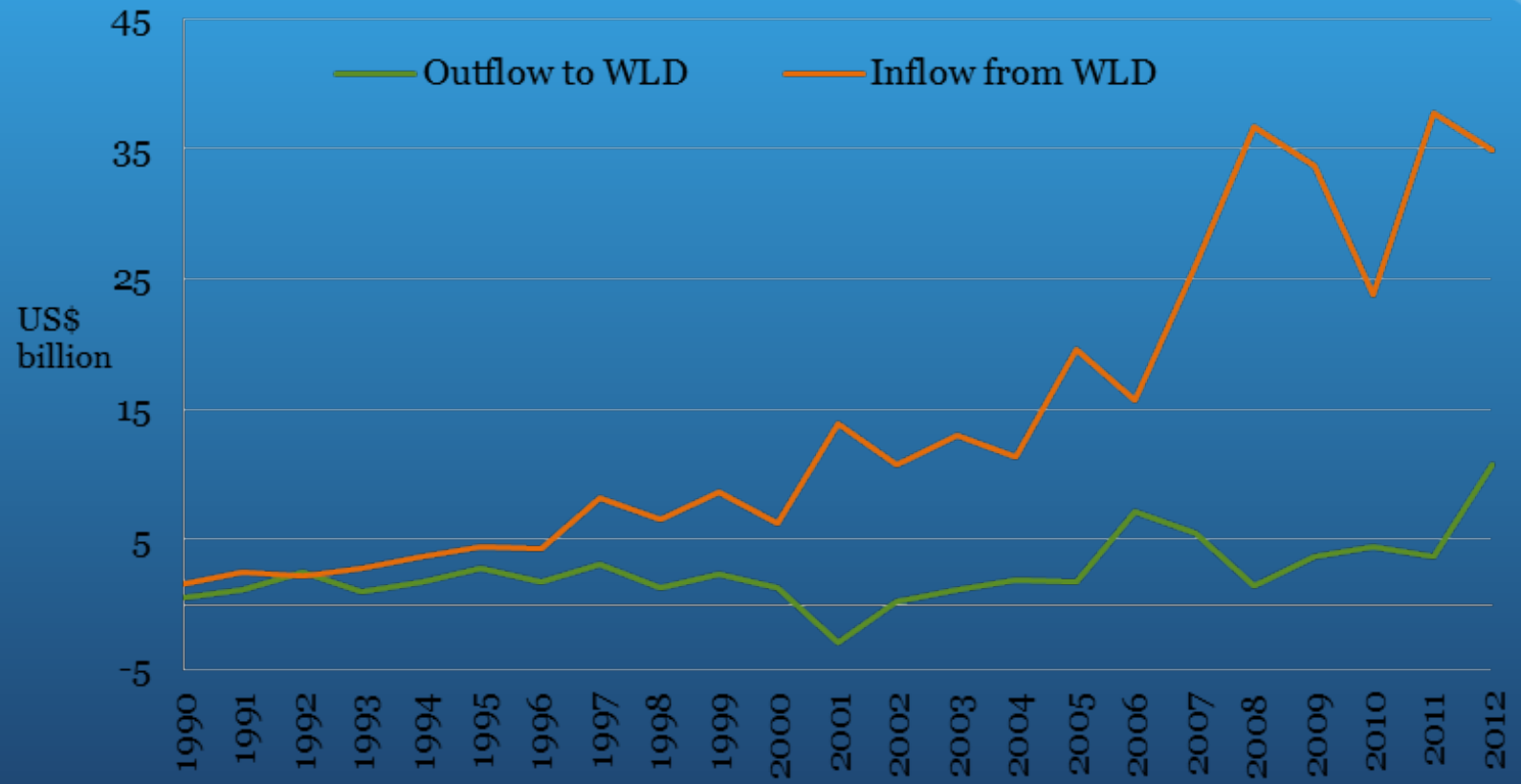
MS4SSA

May15-16, 2017 Boston

Africa's Growth: Recovery in Last 20 Years, Driven by Natural Resources



Foreign Direct Investment in SSA: 600 % increase in 12 years



Source: UNCTAD (2014)
Note: FDI measured in US$ billions at current prices and exchange rate

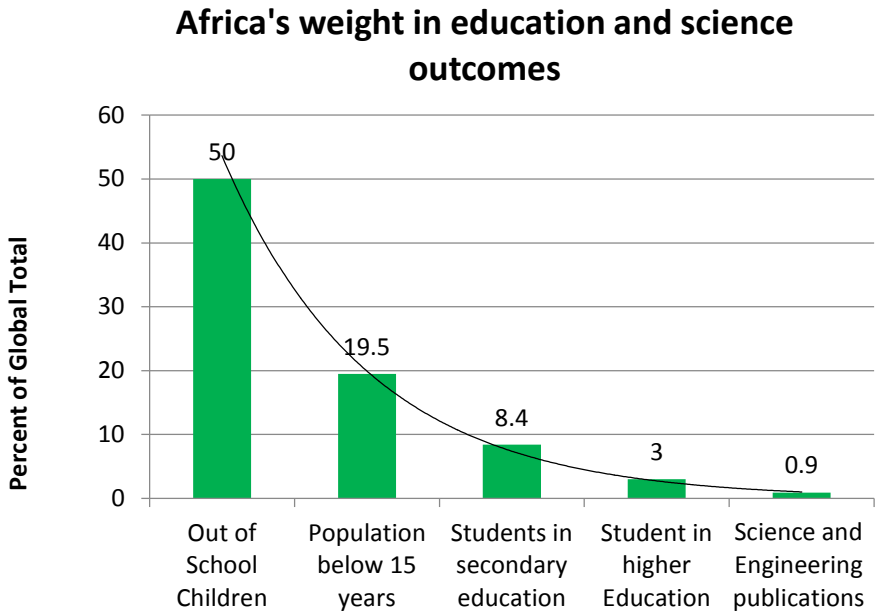
Education and Research: Critical for Innovation

- **Innovation**
- **Adoption, adaptation or creation of technologies that are put to productive use by firms**
- **New product or use of a new production process**

- **Education, Research, ICT:**
- **Education -" Preparation of soil" (Firms need adequately educated and skilled workers to adopt/adapt new technologies)**
- **Research and ICT - " nurturing of soil" (Creates and disseminates knowledge that can be used by firms; connectivity)**
- **Other Factors are Important**
- **Regulations and competition policy: "Weeding"**
- **Finance : " Watering"**

World Bank Innovation Policy (2010)

AFRICA'S CHALLENGES IN EDUCATION AND RESEARCH



Example of skill shortages:

- SSA: 1 medical school graduate per 117,300 habitants (1 to 54,500 for South Asia – 2nd lowest)
- SSA: 11% of all graduates are within natural sciences and 7% are engineers
- Malawi: 0 veterinarians graduated and only 22 working in the country (2009) due to no veterinarian education (80% of jobs and 80% of exports are from agriculture)
- Angola: 20 petroleum engineers per year (oil and gas is 98% of exports)

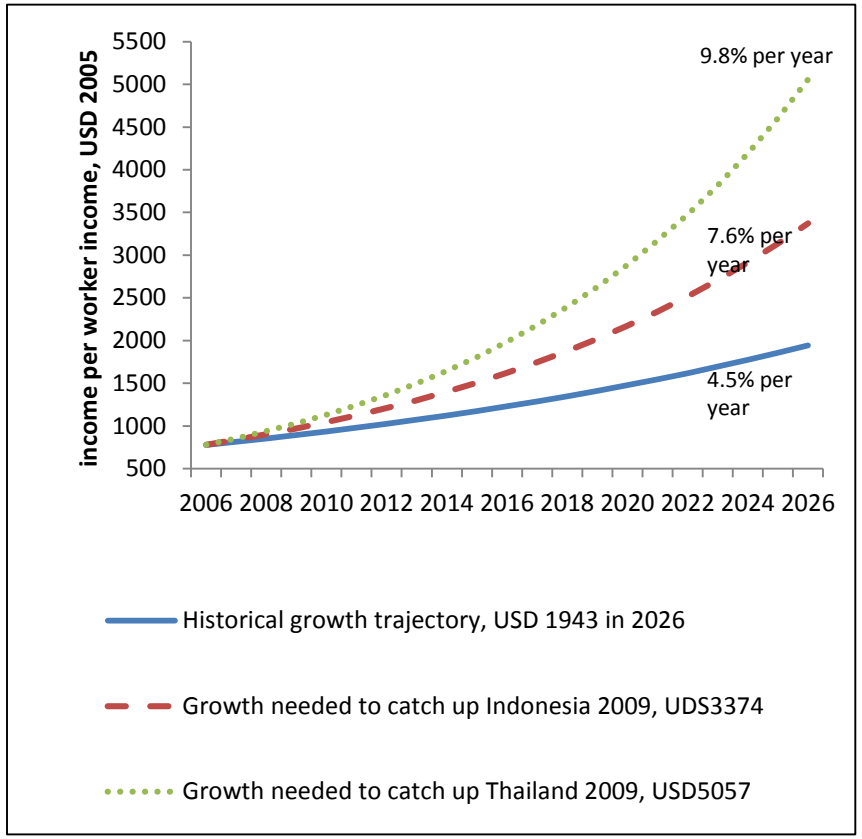
Example of Tanzania

Tanzania's aspiration to attain middle-income country status by 2025

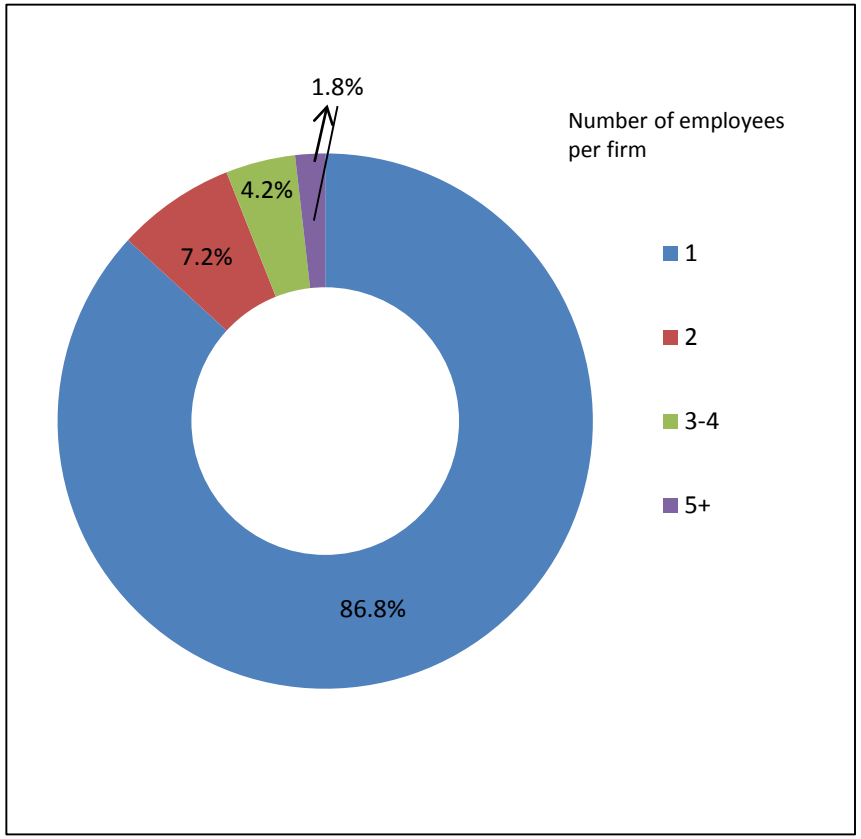
- Through diversification of the economy and more rapid economic growth to create jobs and improve productivity
  - Jobs for 800,000 new labor market entrants each year
- Expansion of employment in existing firms, and creation and growth of new enterprises
- Challenge to develop required skilled workforce to grow new sectors, expand into global markets and innovate
  - given acknowledged education and skill deficits

Tanzania's challenge: promoting dynamic firms, creating productive employment

Tanzania will have to grow faster to catch up emerging countries…



…But most Tanzanians are employed in small firms



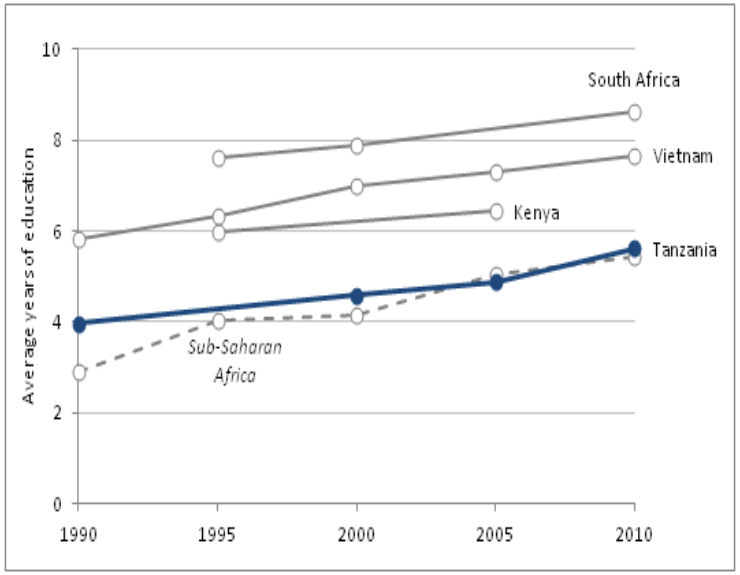
Education Levels in Tanzania

Can Tanzania Grow Fast with Such Low levels of Education?

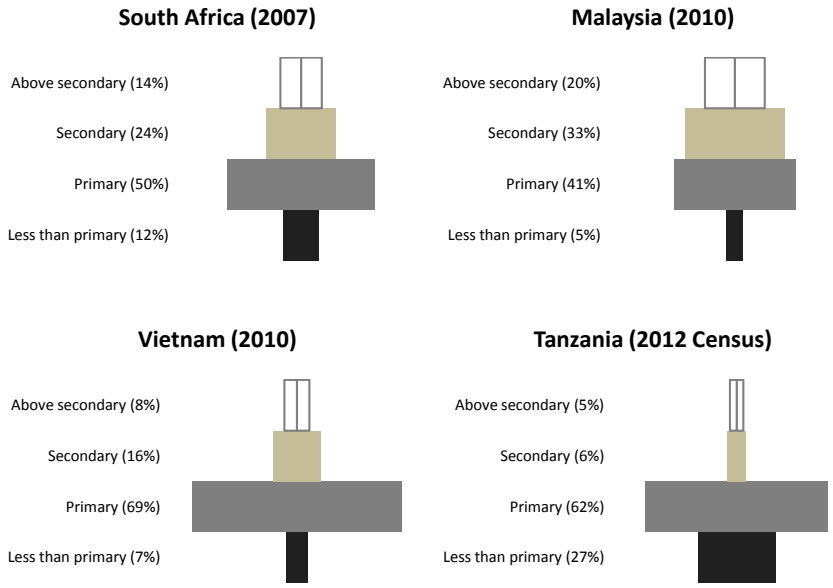
Educational attainment lags behind other SSA middle-income countries

Share of high-skilled workers is low relative to its global competitors

Average Years of Education in Tanzania



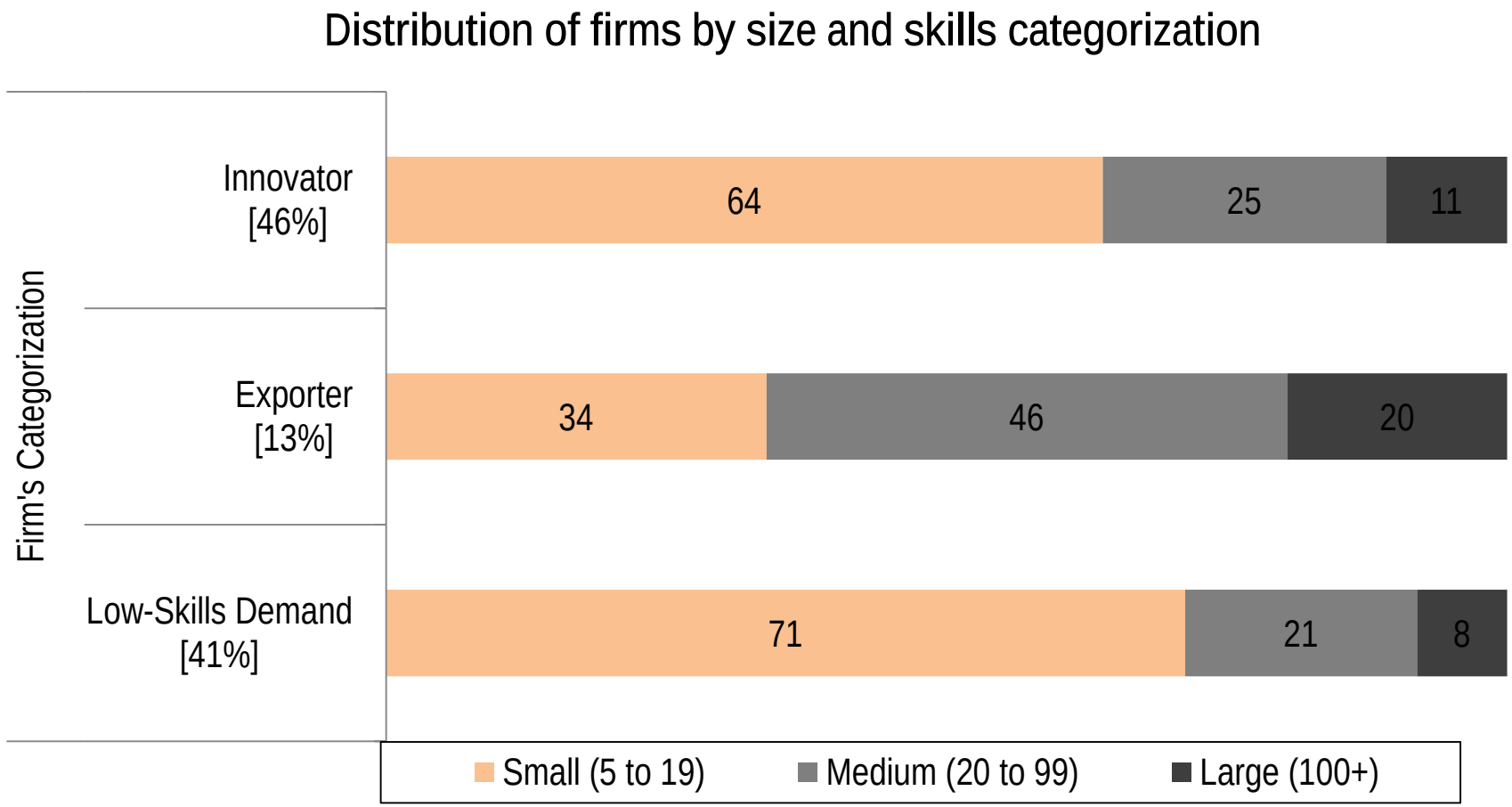
Education Composition



How much should secondary and higher education be expanded?

Tanzania Enterprise Skills Survey (formal sector)

There are innovators in every firm size and sector

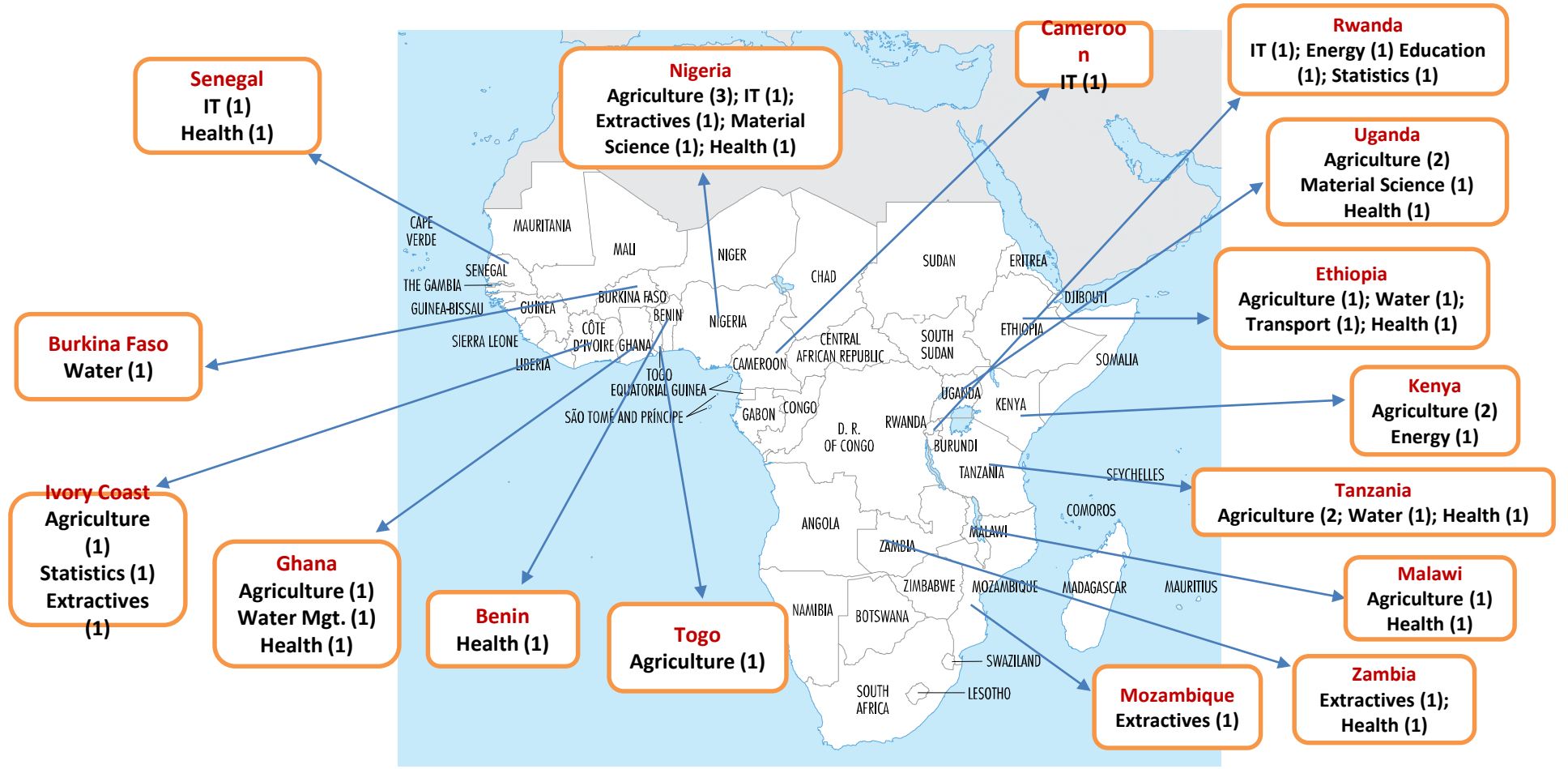


Fostering technology adoption, adaptation and creation

- Most firms (even formal sector ones) in SSA countries are not on the technology frontier
  - They are not creating new technologies
- But a significant proportion are introducing new products and processes
  - A critical mass of technically trained and tertiary educated graduates is required to adopt and diffuse technologies
  - Technician training is as important as university level education
  - Secondary school graduates with foundational skills are required
- For specialized skills, focus for critical sectors (agr, energy, manuf)
  - Firm level innovation depends on knowledge spillovers; more feasible within a sector

WORLD BANK PROJECTS

Africa Centers of Excellence – Regional Project



Plus country specific higher education and skills projects

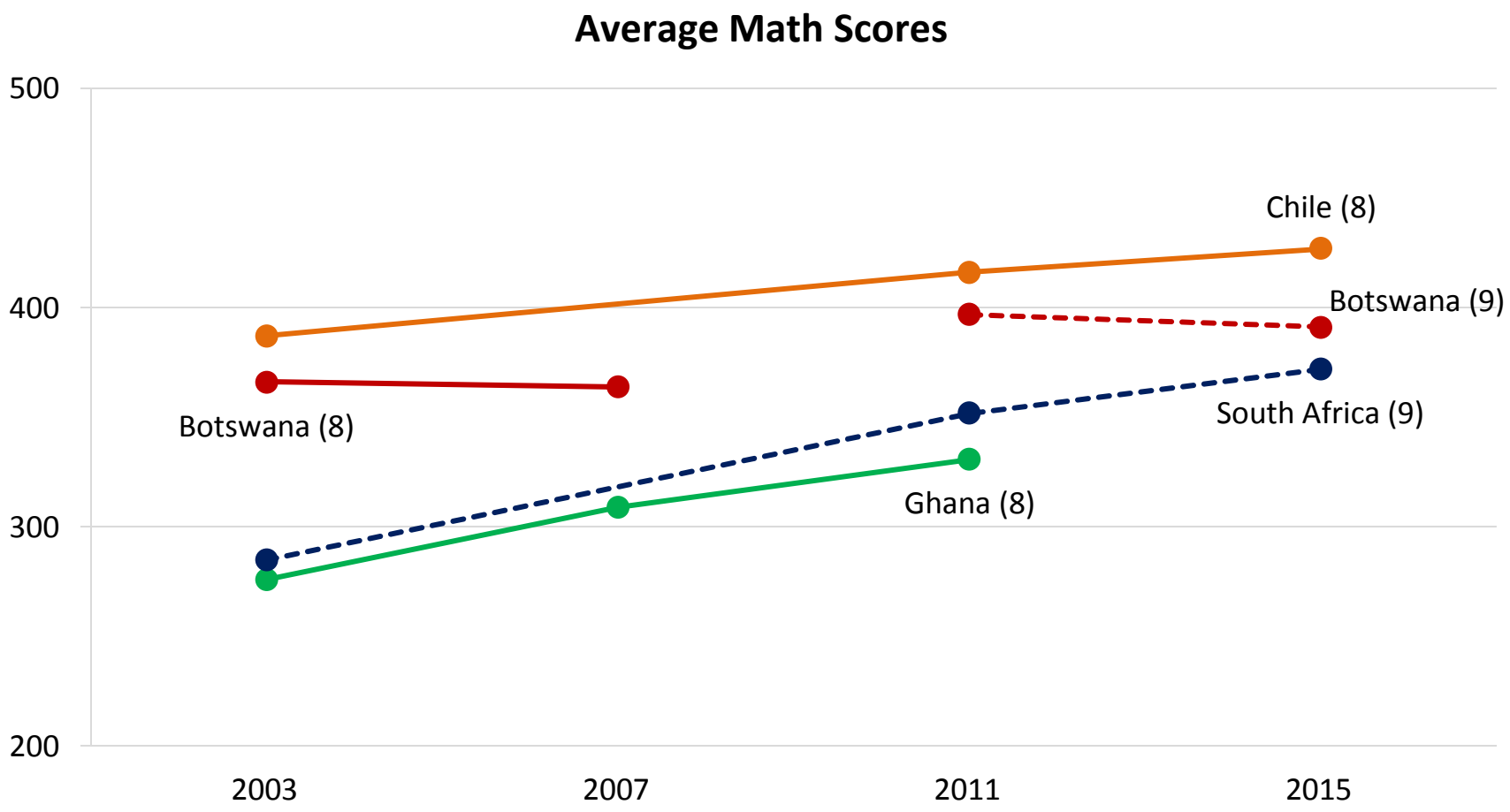
Science and Math in School Education (17 ongoing projects + 2 in the pipeline)

Teachers	Others
➢ In-service teacher training including distance learning ➢ Training of teachers to use teachers guides and subject guides ➢ Provision of teacher guides ➢ Teaching strategies to use low cost and effective ICT ➢ Improvement of pre-service training ➢ Support to teacher professional development ➢ Improve teacher availability in core subjects (including M&Sc) and in rural areas ➢ Incentive scheme for math teachers ➢ Reform of pre-service training ➢ Support to teacher supervision mechanism ➢ Reduce teacher absenteeism and improve time on task ➢ Establish a committee on improving the teaching of mathematics and science	❖ Provision of textbooks and learning materials ❖ Provision of school grant ❖ Provision of Secondary School Performance Awards ❖ Reform of curriculum ❖ Measurement of learning achievements in primary and secondary ❖ Building of scientific and technology blocks ❖ Scale up and evaluate early literacy program ❖ Computer room and laboratories

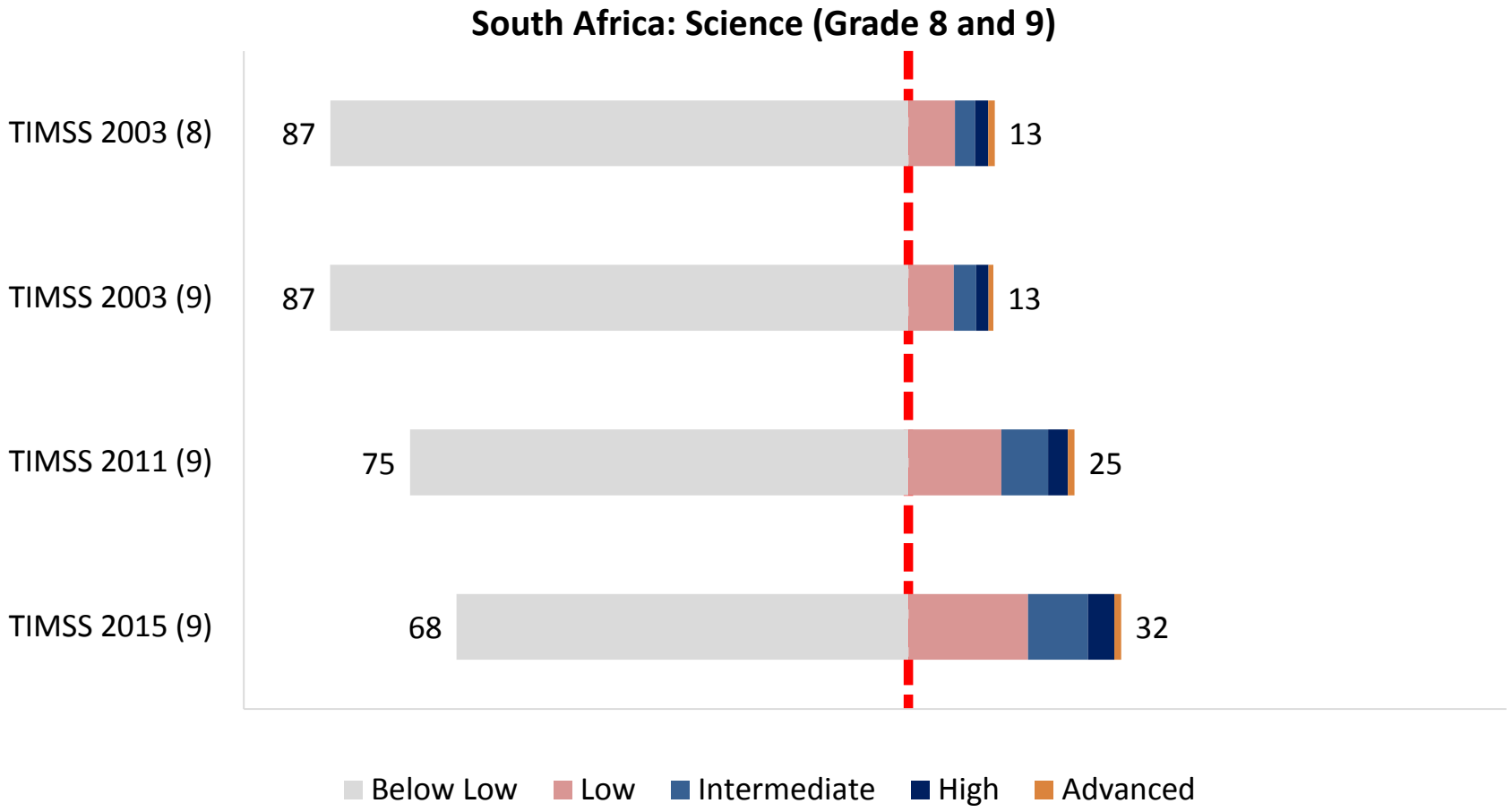
MATH AND SCIENCE EDUCATION OUTCOME IN SELECTED SSA COUNTRIES

Animated

TIMSS: Low Levels, Slowly Improving



South Africa: Improvement in Performance, but 68 percent performing at " Below Low" International Benchmark

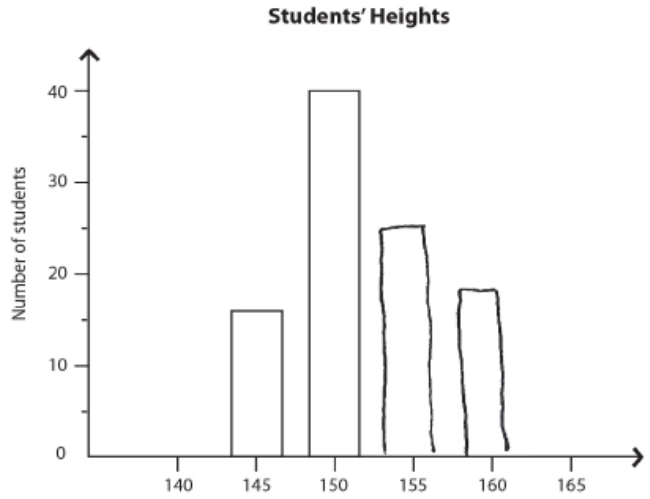


Math: Low International Benchmark (TIMSS, 2015)

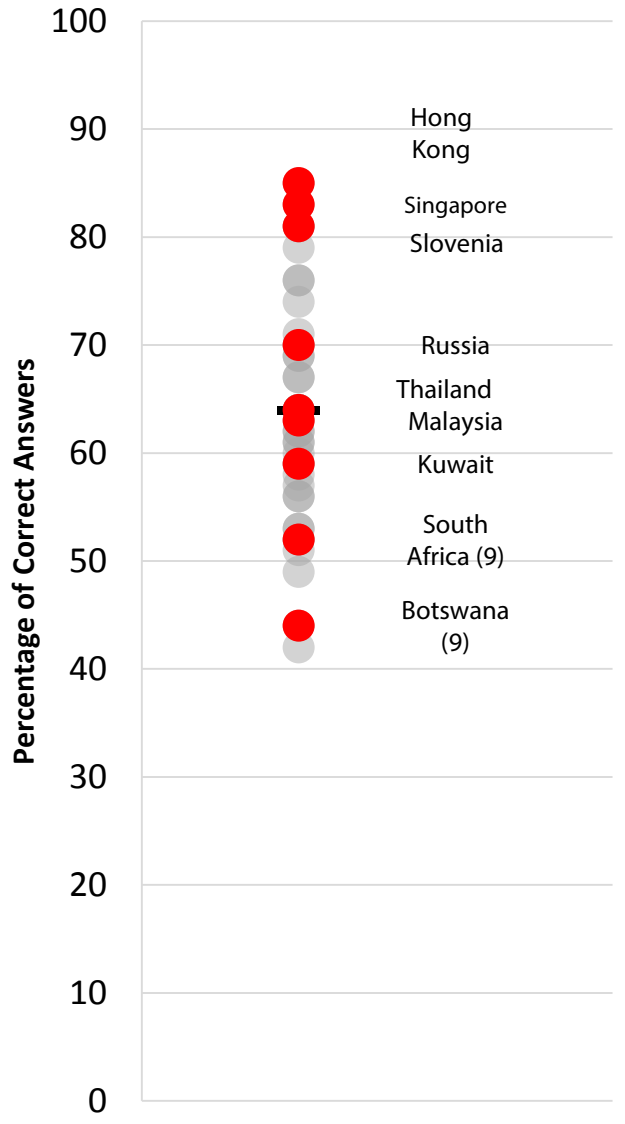
The heights of 100 students in a school were measured to the nearest 5 cm. This table shows the results.

Height (cm)	145	150	155	160
Number	16	40	25	19

Complete this bar chart to show the same information.



- Content Domain: Data and Chance
- Cognitive Domain: Applying
- Description: Uses information in a table to complete a bar graph



Math: Intermediate International Benchmark

(TIMSS, 2015)

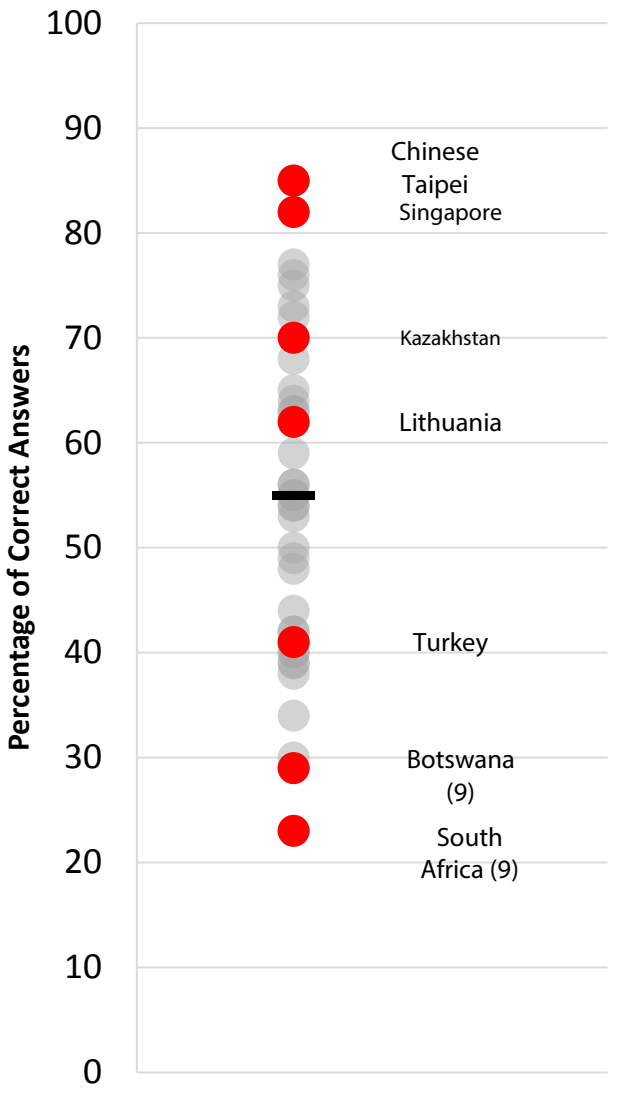
For every whole number n, are these statements **true** or **false**?

Fill in one circle for each statement.

	True	False
$n + 4 = 4 + n$	●	Ⓑ
$n - 5 = 5 - n$	Ⓐ	●
$n \times 6 = 6 \times n$	●	Ⓑ
$n \div 7 = 7 \div n$	Ⓐ	●

The answer shown illustrates the type of response that would receive full credit (1 point).

- Content Domain: Number
- Cognitive Domain: Knowing
- Description: Recognizes the commutative property



Math: High International Benchmark (TIMSS, 2015)

Mobile Telephone

Kate was going to buy a new Supertext mobile phone.

She looked at these two advertisements.

Company X	Company Y
The New Supertext Mobile Phone Get this great phone free! 250 zeds monthly charge Calls 3 zeds per minute Text messages 2 zeds each	The New Supertext Mobile Phone Cheap rates for calls and texts! Buy the phone for 2500 zeds Only 50 zeds monthly charge Calls only 2 zeds per minute Text messages only 1 zed each

Kate decided to compare how much it would cost to have the phone for a year without making any calls or sending any text messages.

A. Work out the cost of having the Supertext phone for a year from Company X and from Company Y.

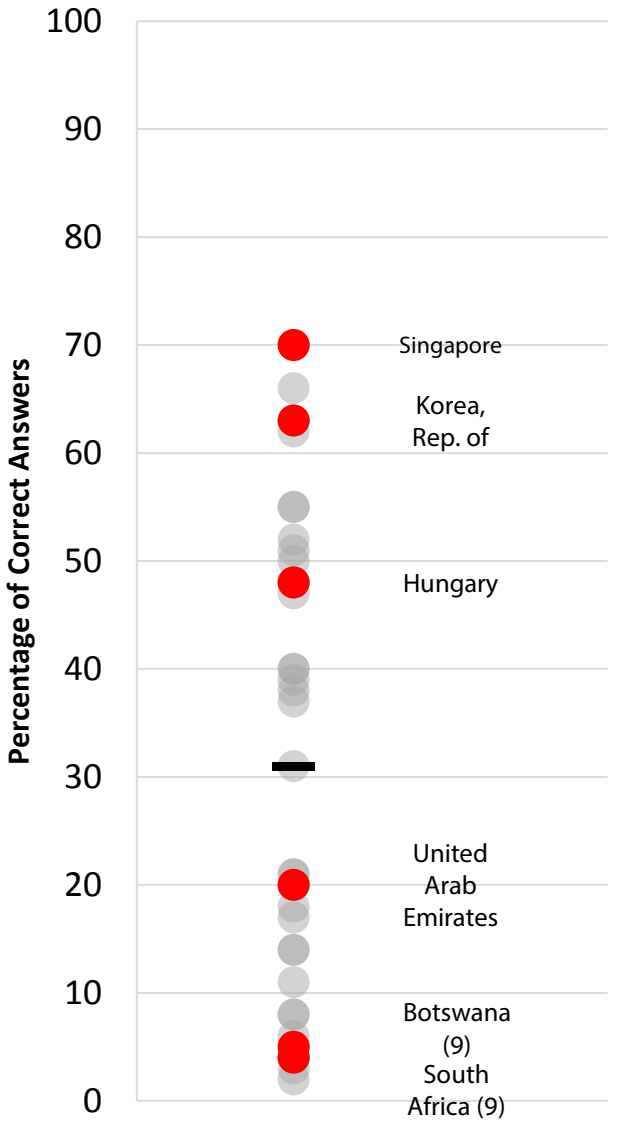
Costs: Company X 3000 Company Y 3100

B. Kate then estimated how much she was likely to use the phone. She thought she would talk on the phone for 500 minutes in the first year and send 200 text messages. Find out how much she would pay for the phone in the first year from each company. Do not forget the monthly charge and other costs.

Costs: Company X 4900 Company Y 4300

The answer shown for part B illustrates the type of response that would receive full credit (2 points).

- Content Domain: Number
- Cognitive Domain: Applying
- Description: Part B - Selects and combines information from two sources to solve a multistep word problem



Science: Low International Benchmark (TIMSS, 2015)

Which of the following is the best conductor of both heat and electricity?

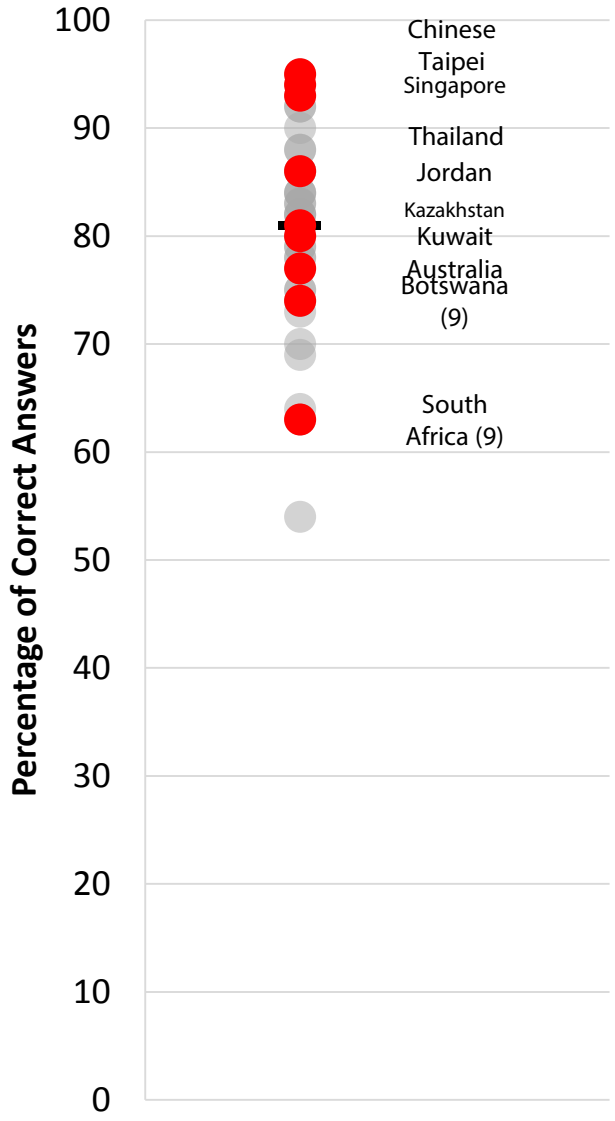
Ⓐ wood

Ⓑ plastic

● copper

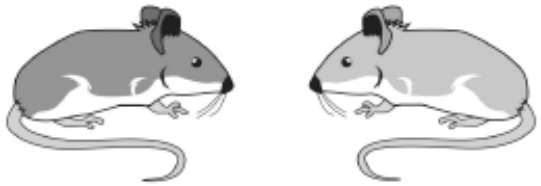
Ⓓ glass

- Content Domain: Chemistry
- Cognitive Domain: Knowing
- Description: Recognizes a material that best conducts both heat and electricity



Science: Intermediate International Benchmark

Deer mice live across much of the world. Those living in woodlands have dark brown fur. Those living on sandy beaches have light brown fur.

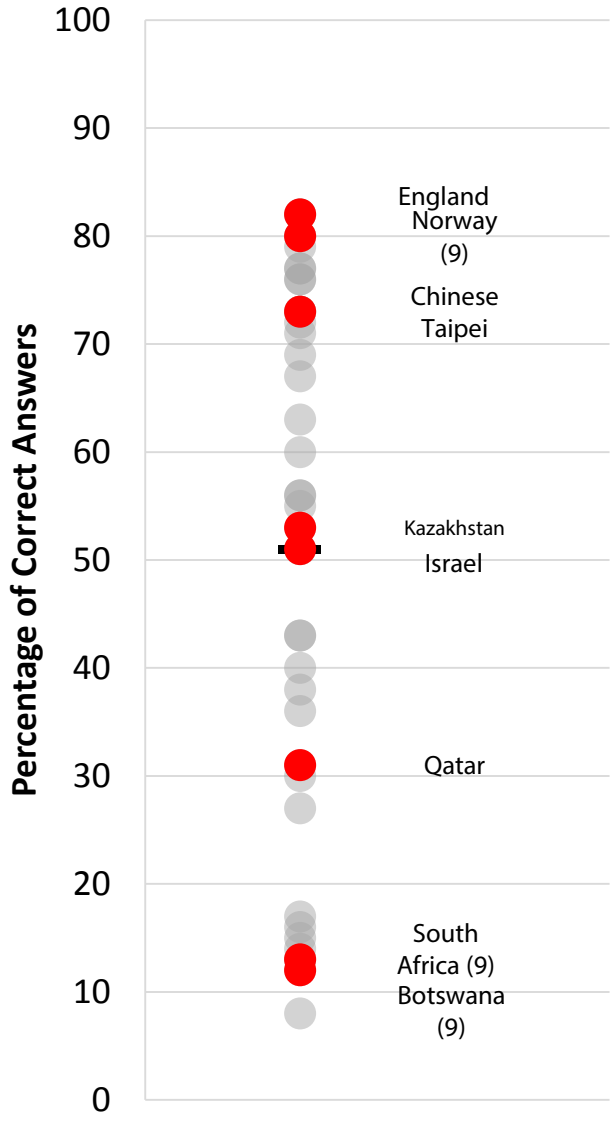


woodland deer mouse beach deer mouse

Why is it an advantage for mice living on the beach to have light brown fur?

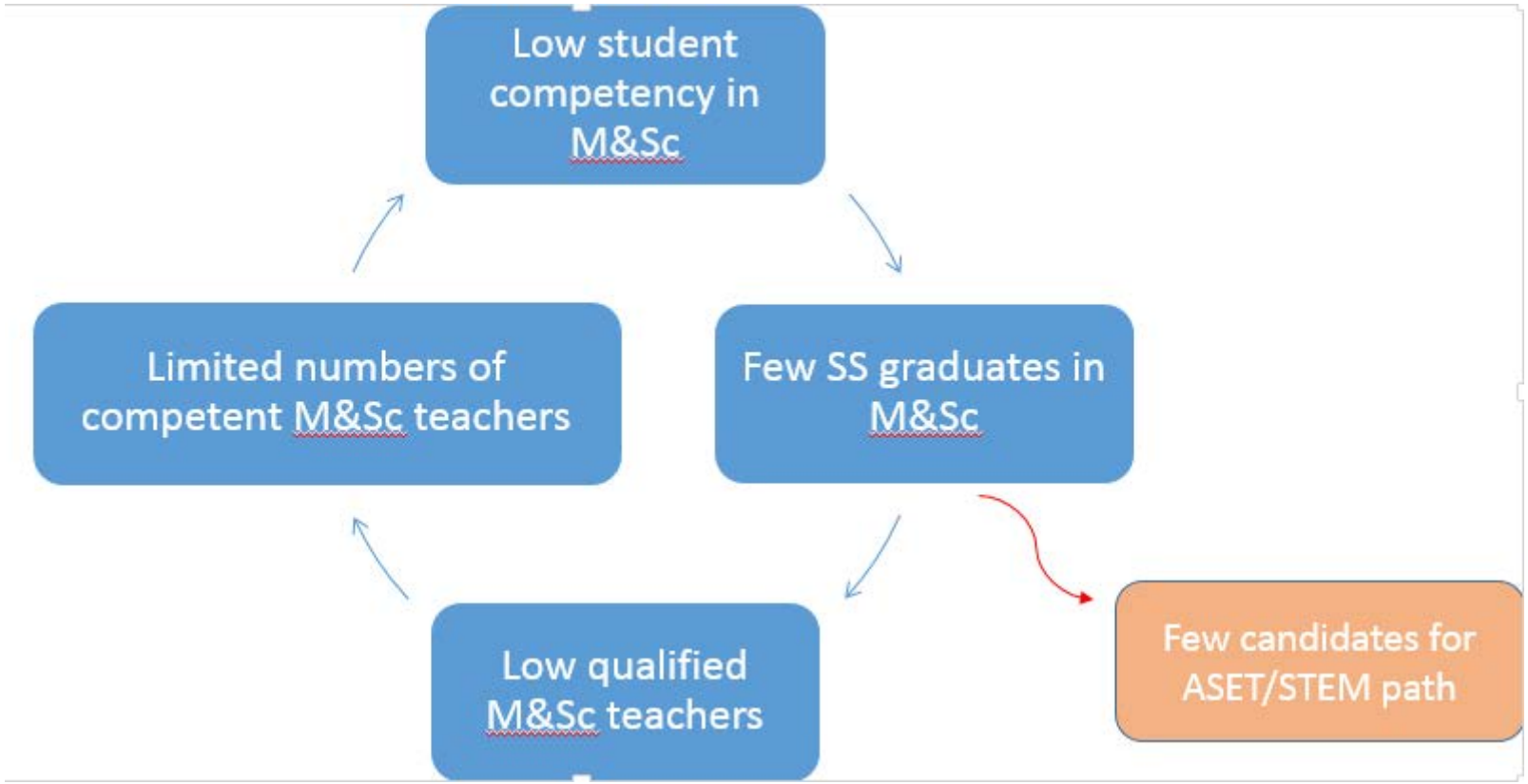
It helps the mice blend in with the sand.

- Content Domain: Biology
- Cognitive Domain: Applying
- Description: Explains the advantage for a species of mice to have coloring matching its environment



NEW REGIONAL INITIATIVE FOCUSING ON MATH AND SCIENCE IN SECONDARY SCHOOLS

Breaking Out of the Vicious Cycle, At a Faster Pace



Dependence on international consultants, no long-term capacity building

Research on Improving Mathematics and Science Outcomes (1)

Raising cognitive achievement in math and science requires evidence-based action to address impediments at multiple levels: classroom, school and system

- ***interventions at the classroom level:*** pedagogy; teacher knowledge and skills; incentives for teachers and students; learning materials; physical conditions in classrooms;
- **interventions that matter aim to strengthen <u>teacher effectiveness</u>**

→***positive impact of adaptive instructional methods on student learning (e.g. computer based)***

→***use of structured instructional materials when teachers' content knowledge and pedagogical skills are weak*** (IE in India and Philippines; digital technology to standardize both content and pedagogical procedures)

Research on Improving Mathematics and Science Outcomes (2)

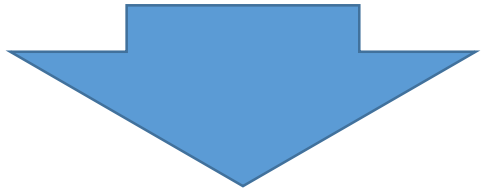
- **Interventions beyond classrooms**: Incentives and Accountability Framework

- **Characteristics of high performing systems**: (a) clear national commitment to high standards for learning; (b) an expectation that all students can meet the high standards; (c) teacher accountability; (d) institutionalization of effective instructional practice; (e) Balance between accountability and autonomy; and (f) policy coherence

- ***Focusing on teachers and their work*** including institutional infrastructure beyond classroom

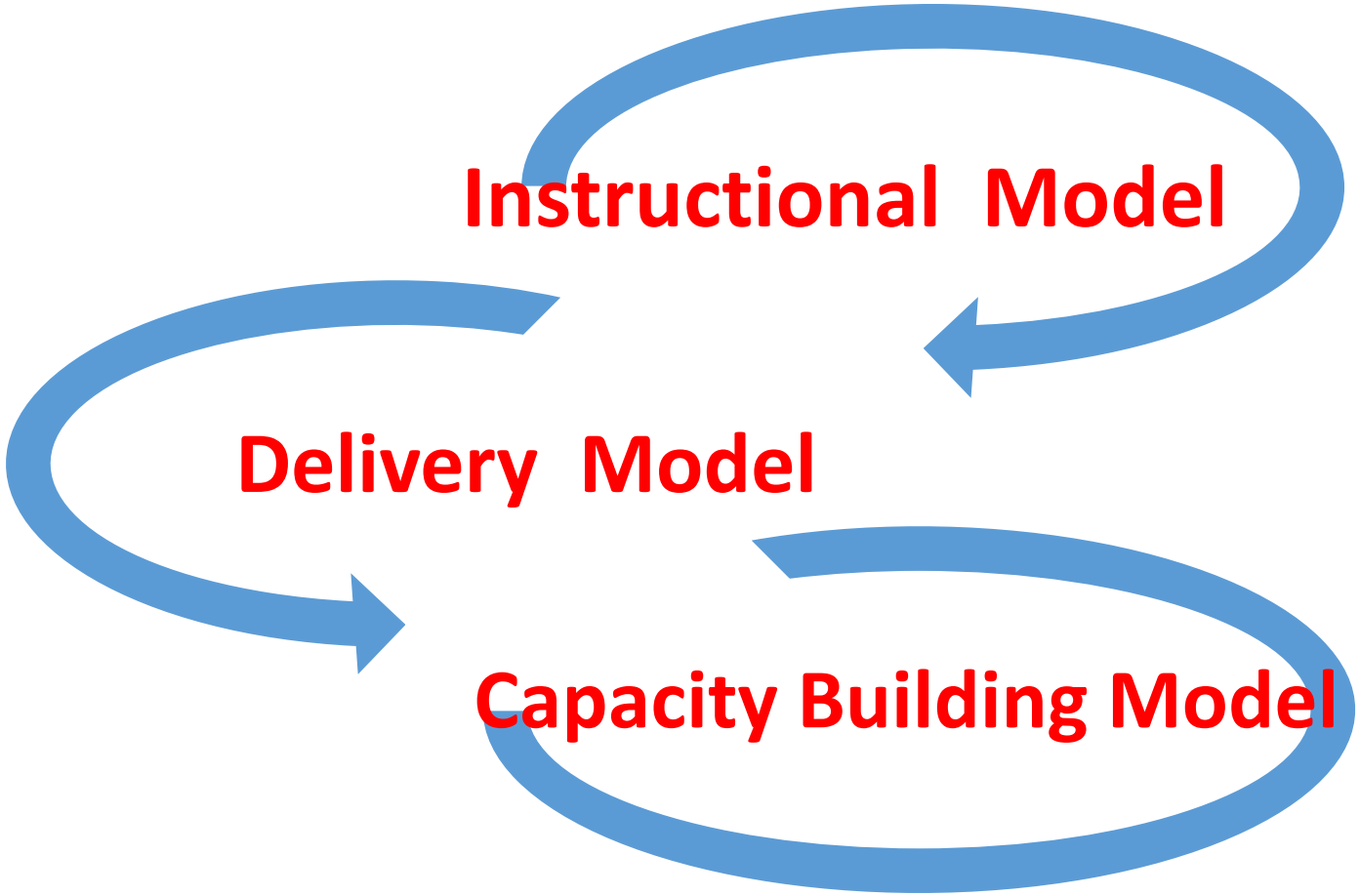
MS4SSA Integrates

- ***Improving mathematics and science learning outcomes in SSA countries needs to integrate key elements around a central focus on improving teacher effectiveness***



- 1) Focus on supporting teachers in classrooms : n**eed of structured approach, with easy to use materials,** student centered pedagogical method, and continuous formative assessment
- 2) Focus on building capacity in Africa for training teachers

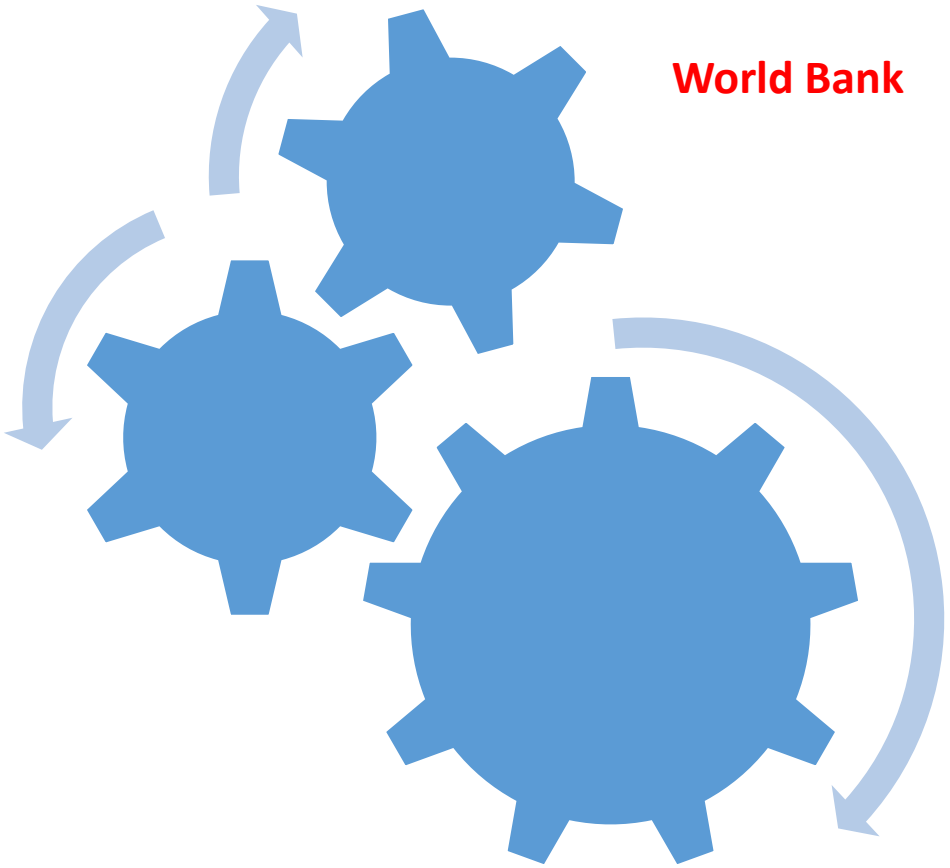
MS4SSA Integrates 3 Interlocking Elements …



Adaptation to Local Context
Learning by Doing

… with Three Interlocking Partners

International Technical Partners:
- WPI and NJCTL;
- International Advisory Committee



World Bank

African Institutions
- **Regional Nodes**
- **Country Institutions**

Adapt to Local Context and Build Capacity on Continent