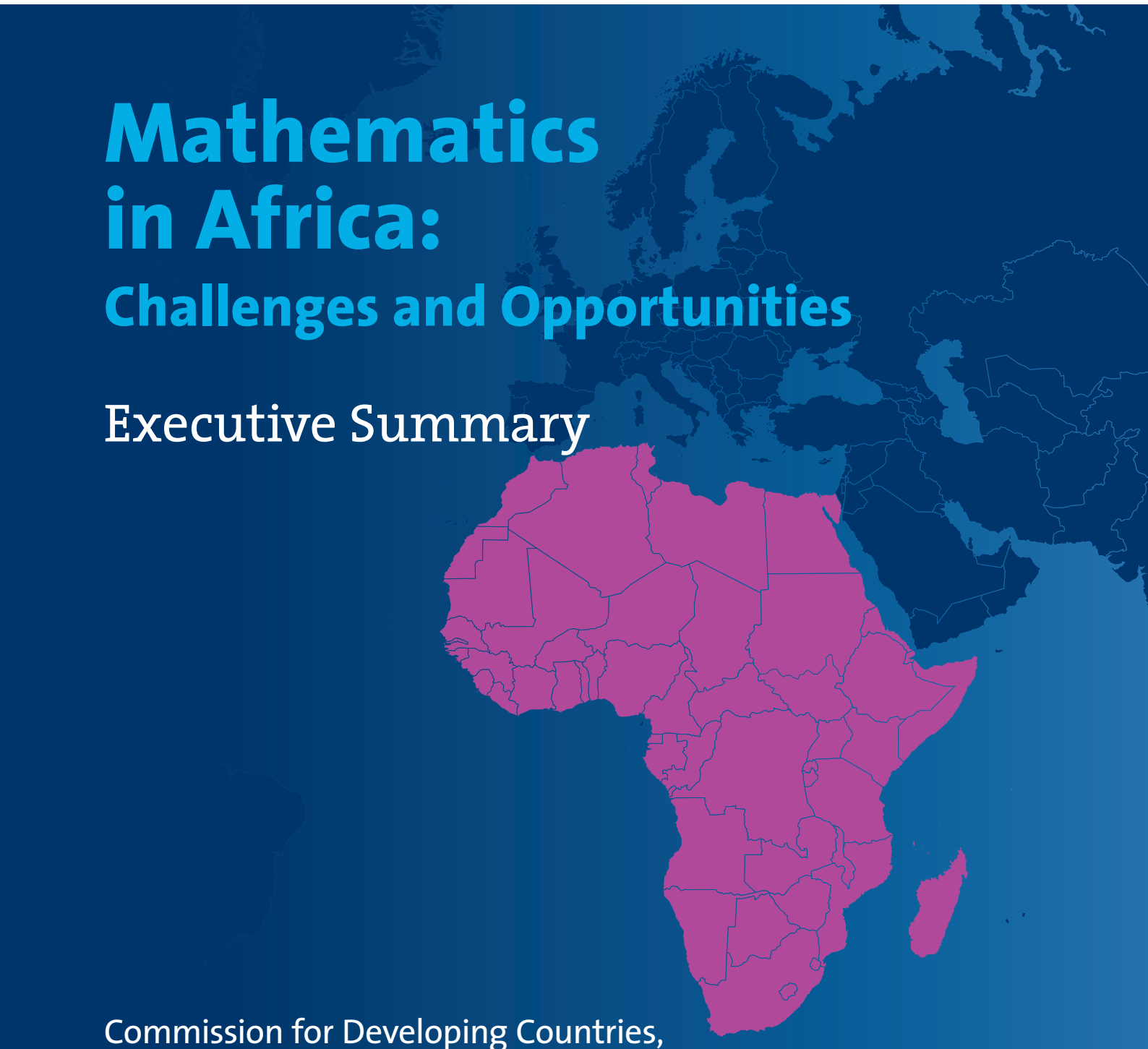
Mathematics in Africa:

Challenges and Opportunities

Executive Summary



Commission for Developing Countries,
International Mathematical Union

Mathematics in Africa 2014

Executive Summary

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This Executive Summary accompanies the full text of *Mathematics in Africa 2014*. That report[1], in turn, serves to update its predecessor, *Mathematics in Africa: Challenges and Opportunities,* which was prepared in 2009 by the IMU for the John Templeton Foundation.[2]

While there have been instances of remarkable progress since the 2009 Templeton report, the majority of the challenges outlined in that report still impede the development of mathematics research and education across Africa. The 2014 updating highlights several of the Templeton report's central themes, and is supplemented by six country "Snapshots."

Preparation of both the 2009 report and the current version has depended on the contributions of generous advisors, most of whom are African mathematicians. While African countries differ from one another in many features, our advisors report broad similarities in key issues of concern. These include:

- Low numbers of secondary school teachers and mathematicians at the master's and PhD levels
- Professional and geographical isolation, which limits opportunities to advance professionally
- Low salaries, a poor public image of mathematics, and shortage of mentors
- Record numbers of students clamoring for a college education
- Deficient and outdated infrastructure, instrumentation, and teaching materials
- Insufficient government support for the mathematics enterprise

Overall, the story of mathematical development in Africa is one of potential unfulfilled. Based on the outstanding achievements of some individuals and institutions, it is clear that no African country lacks talented potential mathematicians. But without a stronger educational structure at all levels, few of them are able to reach their potential.

In brief, African nations need more support for those who wish to become researchers and educators in mathematics, and more collaboration among institutions and people seeking to make this happen. Necessary steps include:

- More relevant and exciting teaching of primary and secondary students
- More direct government support for teachers, faculty, and infrastructure

[1] http://www.mathunion.org/cdc/research-and-useful-links/

[2] The 2009 report can be found at: http://www.mathunion.org/fileadmin/IMU/Report/Mathematics_in_Africa_Challenges___Opportunities.pdf

- Strengthened and expanded training and research activities, especially regional networks of people and institutions
- Scholarships for graduate students and fellowships for faculty
- A clearer path to interesting, rewarding mathematics-based careers

Our IMU advisors have identified and summarized a variety of challenges and potential responses according to the regions where they live:

Southern and Eastern Africa

- Identifying talent: Few countries have screening tools to identify talented mathematics students or career development opportunities for these students.
- Most students continue to be taught by rote blackboard presentations and lack exposure to real-world problems in mathematics.
- Few universities are linked or networked with others in ways that could coordinate training and leverage various scattered specializations.
- Nearly half of Africans who study abroad do not return to Africa due to lack of local employment or research opportunities.
- Because few governments award research funds, there is little incentive to do research in mathematics.
- Most countries have few employment opportunities for mathematics graduates. Suggested steps include mathematics contests to identify talented students and mentoring assistance to help students move toward math-intensive careers.

North Africa and Francophone Sub-Saharan Countries[3]

Among African countries, those of North Africa are relatively advanced in mathematics, due partly to governments' commitment to research and education, and support from nearby southern Europe.

Farther south, francophone Africa, reflecting its colonial past and continued support from the world-wide *francophonie,* is also relatively advanced in secondary and tertiary mathematics, but its strength in pure math is not matched by activities in applied fields. This limits the ability of students to envision career opportunities beyond teaching.[4] Among issues described at greater length in the full report are the following:

- Reforms: the LMD (License, Master, Doctorate) reform aims to modernize learning and teaching by using ICT to prepare and deliver courses. Courses are structured to allow students to study first by themselves and then "face-to-face" with teachers. These courses are designed to develop thinking skills, initiate problem-solving, and encourage creativity. Traditional lectures are eliminated, and a new evaluation process tracks student progress in continuous fashion. Thus the LMD reform requires new behaviors, learning environments, logistics, and funds, many of which are

[3] This section was contributed by Prof. Nouzha El Yacoubi, AMU Vice-President (North Africa), University Mohammed V-Agdal, Rabat, Morocco. It has been edited somewhat for length.
[4] This introduction, adapted from the 2009 Templeton report, is reiterated by Prof. El Yacoubi for the current report.

lacking in francophone African countries. Other barriers are aversion to change by teachers and students, overcrowded classrooms, inadequate technology, and poorly qualified staff. While adoption of the LMD has allowed some universities to move closer to European levels, more thorough assessment of the reforms is currently underway.

- Teacher training: After 1980, low public budgets in sub-Saharan francophone countries forced the reduction or even elimination of funding for teacher training and development. Despite efforts by governments between 1995 and 2005, countries still lack sufficient numbers of qualified teachers. While a new training policy is successful in Morocco, Tunisia, and Algeria, low public budgets have reduced or eliminated programs in sub-Saharan countries.
- Efforts to popularize math in schools: Math is not popular among francophone school children, although support for math Olympiads is growing.
- Gender and mathematics: Special projects have been launched to promote increased enrolment of girls in science, mathematics, and technology in Africa, where participation rates are low.
- Conclusion: While government support has increased primary and secondary enrolments, these are not matched by adequate teaching or learning resources. There is great need for better training and development of teachers, particularly at the secondary level. The IMU, through the ICMI and in collaboration with UNESCO, has created the Capacity and Networking Program in the Mathematical Sciences (CANP) to address this need.

African Networks in Mathematical Research and Education

Since the 1990s, both African and international funding agencies have noticed the effectiveness of networks of institutions in strengthening both research and education in mathematics. The following examples include networks at various stages of development and scale.

- Ethiopia: One of the more successful collaborations is that between the Addis Ababa University mathematics department; the East African Universities Mathematics Program (EAUMP); Uppsala University in Sweden; and the International Science Program of Sweden (ISP). Ethiopia has reported several advantages, including experience sharing, staff and student exchange, research and training collaborations, and motivating mathematicians.
- The Africa Mathematics Project: Funded by the Simons Foundation, this program began in 2013 with five-year grants to three awardees: Tony Ezome, of the Université des Sciences et Techniques de Masuku, Gabon, whose group focuses on number theory, cryptography and allied fields; Edward M. Lungu of the University of Botswana, whose group studies mathematical biology, random differential operators, geometry, and topology; and Diaraf Seck of the Université Cheikh Anta Diop de Dakar in Senegal, whose group studies the mathematics of complex real-world phenomena such as coastal erosion, urban networks, and cancer.
- AMMSI, the African Mathematics Millennium Science Initiative, established in 2004, is a distributed network of mathematics research, training and promotion. There are six Regional Offices, each run by a Regional Coordinator, located in Botswana, Cameroon, Morocco, Nigeria, Senegal, and Tanzania. The mission of AMMSI is to

nurture the next generation of African mathematicians and mathematical leadership. It administers, among other initiatives, a graduate student scholarship program.

- Mentoring African Research in Mathematics (MARM), a partnership of the London Mathematical Society, the IMU; and AMMSI. Begun with grants from the Nuffield Foundation and the Leverhulme Trust, MARM promotes mentoring relationships between mathematicians on other continents and sub-Saharan African colleagues, together with their students.
- African Institute of Mathematical Sciences: AIMS was established in 2003, near Cape Town, South Africa, as a center for education and research, recruiting postgraduate students from across Africa. AIMS has recently expanded into other African countries as a network called the Next Einstein Initiative.

The full Africa report concludes with “snapshots” of mathematical research and education in a cross-section of African countries: Ethiopia, Ghana, Malawi, Nigeria, South Africa, Tanzania, and Uganda.