“MATHEMATICS ACHIEVEMENT IN AFRICA”

by

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INTRODUCTION

Two weeks ago Jose Emmanuel Carroso of the European Commission, in referring to the state of development in Africa and the world’s response to it, said: “Africa remains the shame of our generation.” Almost on that same day I received an e-mail from Paulus Gerdes, Vice President (for Southern Africa) of the African Academy of Science, about his compilation of a list of African doctorates in mathematics. He said: “The (extended) list that I completed a couple of months ago, included over 2,000 African doctorates in mathematics.” [1]

UNDERSTANDING THE TASK AT HAND

These are certainly two very contrasting statements regarding our beloved continent. Given what is being said about the role of mathematics in economic, technological and scientific development and the objective of this workshop, we might want to reflect on these two realities. How can we ensure that our deliberations here in Dakar could contribute to the process of enhancing Africa’s development? Indeed, this workshop should not just become a talk-shop.

While some of the information in the Gerdes publication is quite recent, it is almost common practice to refer to achievements by Africans in historical terms. One often gets the impression that very little of contemporary interests and impact are worth mentioning when it comes to the contributions by Africans in mathematics (education). On the other hand, it is from these historical achievements that we derive our contemporary interests and energies to contribute to ongoing research and development. One should, however, also be mindful of the fact that the rate of scientific discoveries and knowledge generation has grown multifold. The era of supercomputing allows researchers to communicate at high speed. And, given Africa’s general lack of communications infrastructure, it is reasonable to ask whether there is a way in which African scholars and researchers can keep up with their counterparts in other parts of the world. In our search for a Collaborative Research Agenda for Mathematics Education in the U.S. and Africa, we should be aiming at closing the digital and communications gap as a first and essential step towards closing the knowledge generation gap. We are living in an uncompromising era in which there is increasingly less empathy for developing countries. (M&G picture) Under such circumstances it does not pay to look for help from the well-endowed. Their only aim is to stay ahead.

How does one then respond to the topic at hand, viz., Mathematics Achievement in Africa? It is, probably ludicrous for any individual to try to present a complete view on this topic or indeed all the challenges facing Mathematics Achievement in Africa. Yet, my gut feeling is that it will be more
manageable and, perhaps, more balanced to consider some of the achievements and challenges impacting on these achievements. It is often common practice to throw everything which is to be said about the African continent in one basket as if to say that there is a monolithic Africa out there. Africa is huge. There are large differences in a range of human endeavours. Just think about her landmass, population, cultures, languages, economic and educational systems, industrial capacities, and historical backgrounds and developments. In the same way its achievements in mathematics have been influenced by these differences. What is, perhaps, common about these achievements, is the fact that they are not generally known in or outside Africa.

What would be one’s criteria or yardstick for measuring achievements? Is it a competition listing and comparing the achievements of individuals, e.g.,

- ‘The Greatest African Mathematicians’? If so, who are the Africans? Only those living and working on the African continent? Does one include those in the African diaspora?
- Are we ignoring the African-ness of African Americans or Afro-Caribbeans?
- Are we ignoring the African-ness of caucasians/whites born and raised on the continent? Is it at all relevant for this discussion?
- Do we, in the continent, continue to cut ourselves in two by continuing to refer to Northern Africa and Sub-Saharan Africa? This is precisely the way others would have us do? Indeed, who are we?
- What should be considered as a mathematical contribution? Research outputs only? Does one take into account the impact of material contexts such as research opportunities, financial resources and availability of journals?

SOME VERY EARLY MATHEMATICAL (LIKE) ACTIVITIES IN AFRICA

Mathematics, even though not always formally pursued, extends far into our human past. During excavations in the 1970s, a small piece of the fibula of a baboon, the Lebombo bone, was found in the Lebombo Mountains between South Africa and Swaziland. It was marked with 29 clearly defined notches, and at 37,000 years old, it ranks with the oldest mathematical objects known. [2] The bone resembles the calendar sticks, still in use by Khoi-khoi clans in Namibia. The second oldest mathematical artifact is the Ishango bone which date was estimated between 9,000 and 6,500 B.C. While the Belgian archeologist, Jean de Heinzelin, described it as a small tool handle with a quartz fragment in its head, possibly used for engraving, tattooing or writing, Alexander Marshack concluded that it represented a six-month lunar calendar and dated the bone between 23,000 and 18,000 B.C. These artifacts show that Africans were doing mathematics thousands of years ago. [3]; [4]

A brief summary of the Rhind Mathematical Papyrus was provided in one of the publications of the SUMMA Program. The following are some of the interesting facts mentioned: The Rhind Papyrus was copied by the scribe Ahmose around 1650 B.C from an older document made during the 12th Dynasty, about 200 years earlier. The Rhind Papyrus contains 87 problems, preceded by a table of fractions with numerator 2 and odd denominators 3 to 101, decomposed as fractions with numerator 1. Apparently computer generations of all possible such combinations did not yield simpler results than those of the Egyptians. Problems in the papyrus include operations with fractions; solutions of first degree equations by the method of false position; sums of arithmetic and geometric progressions; areas of triangles and circles \[A=(8d/9)^2\] giving \[\pi=3.16\]; volumes of cylinders; and the slopes, altitudes and bases of pyramids using rudimentary trigonometric functions. Translation of a clay tablet in 1945 showed that the Babylonians knew the famous theorem of Pythagoras more than 1,000 years before the birth of Pythagoras. [4]
A ROMANTIC MATHEMATICAL STORY FROM ELSEWHERE

When one considers the life stories of achievers one expects to hear about all the positive influences on their lives. In thinking and reading about Africans who have achieved in mathematics or, more broadly, mathematical sciences, I was looking for such influences. Achievements are usually measured relative to those of others. I was also reluctant to simply compare great African mathematicians. Instead, I chose to first look somewhere else. So in my search for some measure, I came upon the following statements about one such achiever. Though not African, this person came from a challenged background during a time when communication was not at all easy. I read the following about him: “He unceremoniously flunked out” of high school. “He would later get a second chance but “he flunked out a second time.” He “was an academic failure”. But, then I also read the following statements: “This true story is one of magic. (He) was an untrained mathematician, toiling largely in isolation, whose work was born entirely out of imagination. He was a pioneer and self-taught anticipator of great mathematics, and is indeed magical. After all, great mathematics is magic, something we can understand but whose inspiration we cannot comprehend. (He) was a gift to the world of mathematics.” [5] There is a major surprise in what was quoted above. Firstly, these quotations refer to a person born in the 1880s. Secondly, this person eventually did his major research mathematics at one of the world’s most prestigious universities. Thirdly, he came from, what is nowadays called, a developing country. He was of course Srinivasa Ramanujan, the great Indian number theorist. His story is one of the world’s greatest achievements. What is important about the Ramanujan story is that “despite his failures, his friends and parents supported him. … They allowed him to work on mathematics unabated.” [5] Ramanujan did his research in near isolation since fellow Indian mathematicians did not understand his work. Even though their stories may not be as romantic as that of Ramanujan, it may be interesting to delve into and relate the stories of some African achievers in mathematics.

A CONTRAST OF RECENT ORIGIN

But for now, I would like to contrast Ramanujan’s story with the next scenarios starting with the following quotation: “Do not teach a black child mathematics and science. It will not need it.” [6] This was a statement made in the South African parliament some 53 years ago by the then Minister of Bantu Affairs, Dr Hendrick Verwoerd, also viewed as the architect of grand apartheid. What is significant about Verwoerd’s statement is that it has actually become the de facto policy in the way the government of the day dealt with the educational provision of black learners. In fact, it can be said that science and mathematics became the most neglected areas in the curriculum for blacks. While such sinister policies were not enforced in other African countries, the impact of colonialization and exploitation resulted in similar conditions for the populations of most of these countries. For example, at the departure of the Portuguese from Mozambique in the early 1970s, there were only a handful of qualified secondary mathematics teachers. In general, starving the local population of decent and effective education was used as a weapon to halt or, at least, retard development.

WHAT ELSE FROM AFRICA?

The vast difference in the quality of the outcomes of the two scenarios related above, leaves us with many questions and lessons. It may be a good idea to research the twentieth century scenarios in the (under)development of mathematics and science education in various African countries. One should also get a sense of the ‘brain drain’ which might have taken place over the past two decades or so. This
might be the most significant reason for the somewhat negative state of mathematics and science education in Africa. Addressing the major reasons for qualified scientists to circum to the attractiveness of factors which enhance ‘brain drain’ might provide an indication of how to advance ‘brain gain’ or, at least, ‘brain circulation’ which could one of the pillars of the approaches embedded in the envisaged agenda for African-US cooperation.

How could African scholars working outside Africa continue to collaborate with scholars in the continent? Have we become too globalised in our aspirations, thoughts and actions and how is our connection to the continent influenced by this global movement? Will it help to inspire us if it is said that:

- There are interesting references to numeration in Africa. [7]
- There are interesting examples of geometrical ideas in traditional African building, as well as architectural shapes inspired by African art and craft. [8]
- There were mathematics books in the 14th century university library of Timbuktu? [9] In fact, it is believed that the libraries of Mali contain scientific manuscripts but the majority of them have not yet been studied. The question is: Is it possible for Africans to rekindle the spirit of Timbuktu or the mathematical insights embedded in basket weaving?

SOME KEY (EXISTING) DOCUMENTATION

Let me conclude this incomplete effort at highlighting some achievements in African mathematics by referring to the information in the Gerdes-Djebbar bibliography and on the Scott W. Williams website.


Without concentrating on particular achievements, the recent monumental work by Paulus Gerdes and Ahmed Djebbar [10] has resulted in highlighting the presence of mathematics in African history. As key players in the AMU Commission on the History of mathematics in Africa, the authors have over the years tried “to stimulate research and collect and disseminate as much information as possible about the history of mathematics in Africa”. This bibliography has attempted “to encompass the African continent as a whole … without forgetting the historical links across the Mediterranean and the oceans”.

In a series of appendices to their mammoth publication, the first Gerdes and Djebbar included the following topics:

- On mathematicians of African descent/Diaspora;
- Publications by African scholars on the History of Mathematics outside Africa;
- On Time-reckoning and Astronomy in African History and Cultures;
- String Figures in Africa;
- Examples of Books and Booklets Published by African Mathematicians;
- Board Games in Africa;
- Examples of African Mathematical Pioneers in the 20th Century; and
- Note on research inspired by the historical reconstruction of mathematical ideas in the ‘sona’ geometric tradition of Southern-Central Africa.

Clearly one would say that these topics are an inadequate representation of the achievements of mathematics in Africa. But, I think it is a very useful start. The mathematical topics selected for
highlight obviously reflect preferences by both or either of the authors. On the other hand, they also put a focus on the role of culture on the development of mathematics in Africa, something which is generally viewed as a degrading of the contributions by African mathematicians or not sufficiently substantial for universal recognition. Yet, such claims are never logically and objectively motivated or the objectionists vacillate in their responses. The authors are also clear about the inclusion of Africans in the Diaspora as well as modern day contributions.

Special reference should also be made of the contributions inspired by the ‘sona’ geometric tradition. The research on this topic includes researchers from outside the African continent. In fact, Wolfgang Jaritz of the University of Graz (Austria) is credited with the first mathematical research inspired by the ‘sona’ tradition of Cokwe and related peoples of eastern Angola and neighbouring regions of Zambia and Congo. [10] This is indeed significant because it points to the universality of ideas and constructs inspired by African traditions. One should, however, realize that the unearthing of mathematical structures inspired by African traditional culture, vision and art is part of a broader ‘movement’ of what has become known as ethno-mathematics and of which Paulus Gerdes and his Mozambican colleagues were, and still are, major contributors. At the same time it should be noted that some of the major critics of ethno-mathematics are Africans. It is argued that ethno-mathematics is an insult to the ‘real’ mathematical creativity of Africans.

The Scott Williams website

There are very interesting contributions made by Scott Williams through his website mentioned earlier. He lists the names of almost 660 African and African-American mathematicians, of whom over 130 are women, with a web-link to information on most of them. [11] Such information is crucial if one hopes to satisfy the purpose and objectives of this workshop have not made matters any easier. After all it is about Setting a Collaborative Research Agenda: Mathematics Education in the U.S. and Africa. So, even though in some respects the information on the Williams website is incomplete, its value cannot be denied and, in fact, a strong word of appreciation to Scott will be in order. For example, the list of African research mathematicians excluded most South African mathematicians. On the other hand, Profiles of Mathematicians of the African Diaspora includes information which one would not find easily in a single publication: It gives us the following ‘indicators’ of mathematics achievements of Africans:

- the most highly cited African mathematicians;
- greatest Black mathematicians;
- Back women in mathematics sciences,
- Black Research Mathematicians & their Books; and
- Black mathematics journals.

In terms of achievements it is inspiring to note that, according to Williams, over 15% (50% more than the general population rate) of all Black Ph.D.’s have published at least eleven mathematics research papers. The criteria used were a strong orientation towards research in the mathematical sciences either by length of career, frequency of publication, or impact of the work, at least 5 papers published in mathematics. (Holding a PhD is not a criterion.) As a measure of comparison, it is noted that the distribution of the total number of papers per author in the general public reads as follows: 1 or 2 articles (57%); 3 articles (8%); 4 articles (5%); 6-10 articles (10%); 11-20 articles (7%); 21-50 articles (6%); 51-100 articles 2%; 100 articles (less than 1%). Note that in the general mathematical sciences
population more than 1,500 people published more than 100 papers, including 8 mathematicians with more than 500. Paul Erdös has the most 1,401.

Scott also provides us with a list of Black Mathematics Journals, not necessarily limited to Blacks. Could this be thought of as another indicator of achievement? Indeed, this is crucial to the development of mathematics. Without the possibility of publishing or making evaluative decisions about the publications of others, there can only be limited growth.

FRAMEWORK FOR JOINT AFRICAN-USA RESEARCH PROGRAMME

Which kind of framework could be considered for or areas covered in a potential joint African and American research programme/project? Even though I was not asked to consider these questions, I thought that just letting it off my cuff may not harm. First of, elements of the framework could include the following:

It should be derived from a critical look at the concept ‘ubuntu’ as one of its underlying principles. The philosophy of ‘ubuntu’ – being a human being through the humanity of others – allows for the genuine voices and contributions of all to be heard and respected.

Since we are looking for a cooperative programme, the implementation of any activity should be based on the concept of ‘brain circulation’ rather than ‘brain drain’. This is particularly relevant since context often plays a crucial role in research results. Thus, the collaborative programme should not leave African countries poorer and favour the USA in a one-sided way. Skills development for real progress based on the application of mathematical knowledge should be pursued relentlessly and jointly.

Another characteristic of the envisioned programme of cooperation is that it will encourage and embrace trans-disciplinarity, especially given the complexity of social, economic and cultural challenges for African nations. This will allow for a holistic approach to the use of mathematics in resolving continental challenges of development. We should critically engage with the concepts of indigenous knowledge or, even more provocative, Africanization of Knowledge. A reference to Ethnomathematics or Realistic Mathematics Education should not scare us.

It is reasonable to expect that the collaborative research programme should always be aimed at addressing the potential needs, expectations and challenges of future generations. Such a futuristic view should be clear while simultaneously flexible. This is no easy challenge for some of the jobs for which the skills of our students should be honed and which might not yet have been defined.

Perhaps one of the most important, but simultaneously challenging, aspects of our expectation of the envisaged programme is the fact that it should be embedded in partnership. There should be a demonstrated belief in the inert academic abilities vested in partner institutions and genuine respect for the local conditions.

Finally, given my earlier comment that the continent of Africa is vast and diverse, further complicated by colonial escapades, serious thought should be given to trans-boundary activities included in the research agenda and the management thereof.

CONCLUSION
Given the long history of mathematical type work pursued in Africa, it is not possible to cover all or even most of the major achievements in mathematics in Africa. It is for that reason that I am appreciating the efforts of Gerdes and Djebbar and Scott Williams. Their efforts could be augmented by research which could be assigned to graduate students. While the author attempted to provide a taste of what is available, it may be a good idea to include more of the history of mathematics in Africa in school and university curricula.

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REFERENCES


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