

Learning How Science Works with Crystals: A Proposal for Africa

Dr. Joy W Kiano¹, Dr. Patricia W Gitari², Ms Lillian Nyaranga³, Prof. Juan M. Garcia-Ruiz⁴

¹Nemayiana, Africa Museum of Science and Technology, ²A.E.S.A, Nairobi, ³Elimu Shop, Nairobi, ⁴Instituto ANdaluz de Ciencias de la Tierra. CSIC-Universidad de Granada,

joykiano@gmail.com

The United Nations (UN) predicts a doubling of the population of Sub-Saharan Africa by 2050, with 60% of that population of working age [1]. With Africa's youth accounting for up to 60% of its population, this growing population is the continent's biggest resource. This resource needs to be harnessed and provided with healthcare and education that gives them the necessary tools for advancing the continent's human capital. Across sub-Saharan Africa, successful science education requires a reignition of excitement and enthusiasm for science, technology, engineering, and mathematics (STEM), in order to create scientifically literate and engaged citizenship. At its best, STEM-based learning can inject relevance, storytelling, meaning, and importance of the living world in all its complexity. Science education should allow students to interact with and learn in an authentic, purposeful way rather than by the simple acceptance of abstract theorem. Teacher development programs in many countries across Africa lag behind when it comes to assisting learners in engaging and immersing themselves in science. It is vital to harness the potential of Africa's growing human capital and provide opportunities for exposure to modern innovation and educational structures that will help bridge the widening gap in the scientific literacy of its growing youthful population [2]. There is an urgency to leapfrog the education system as it stands now and offer youth practical and alternative methods for learning how to develop and engage successfully in the scientific and technological method; how to structure and present scientific and technological information; and finally, how to communicate and collaborate within a scientific and technological community. Crystals and crystal growth have been shown to be excellent tools for introducing young students to the methodology of science and engineering. The natural appeal that children and young people have for crystals has been successfully used in Spain and other countries to introduce not only crystals and crystallography in Schools and High Schools but also to transmit to them how science works and how scientists behave. Inspired by that experience, we propose to create an education program fully adapted to the Kenyan and African socio-economic landscape. Rather than focusing on the students, the program focuses on teachers providing innovative teaching materials on crystal, crystallography and crystal growth. The project objectives are outlined below:

- Organization of a three days course on "Crystallography at the School". Professor Juanma García-Ruiz, Dr. Joy Kiano, Dr. Patricia Gitari, and Ms. Lillian Nyaranga will teach the course. It will be performed in the Faculty of Science and Technology of the University of Nairobi, which provides classroom and laboratories. It consists of the following activities:
- Lectures on "Introduction to the world of crystals"; "The birth and growth of crystals"; "The use of crystals in Medicine and Pharmacy"; "The role of crystals in Materials Sciences"; "The role of crystals in Earth Sciences, Chemistry and Agriculture".
- Practical Crystallization: Hands on crystallization from solutions & gels.
- Screening of movies related to crystals
- How to use microscopes and video microscopy
- Organization of a crystallization contest where students can learn how science works. This will consist of the following steps:
- Selection of teachers and Schools
- Providing the crystallization kit and the crystallization compounds
- Students work at the schools for 2.5 months
- Continuous tutorial of teachers
- Deadline for receiving the student's projects.
- Selection of the Jury's members
- Final Contest at the Institute Wangari Maathai.
- Reception of the posters submitted by the students
- Printing of the posters.
- Students Conference: the students show to the public and other students the results of their crystallization experiments, their notebooks, their videos, their posters, and other results of their investigations.
- The jury visits all the student projects and discuss the results with the authors. The jury evaluates and selects the best projects.
- Awards ceremony
- Party
- Exhibition on why crystals are important
- We will exhibit the 14 posters of the exhibition CRISTALES [4] and translate into English the website of the exhibition. In addition, we are designing a totally new exhibition ad-hoc designed for the Kenyan and African context.
- The exhibition will be permanently displayed at the Institute Wangari Maathai in Nairobi.

References:

{1} *The Economist Special Report 2020: Africa's population will double by*

2050. <https://www.economist.com/special-report/2020/03/26/africas-population-will-double-by-2050>

{2} Joy W. Kiano, *Notes on STEM Education in Sub-Saharan Africa*

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{3} *Cristales: Un Mundo por Descubrir/a World to Discover (2015). A Bilingual Guidebook of the Exhibition. Granada: Triana Science & Technology.*

{4} Juan Manuel Garcia-Ruiz, Fermín Otálora, et al., *CRISTALES: a world to discover. An exhibition for schools and universities. J. Appl. Cryst. (2015). 48.*



Figure 1