Posing Big Questions and Developing Tools for Learners: Physics Education and Outreach

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Activities that engage learners in the big questions of physics inspire their work and give them direction. Africa is becoming ever more deeply involved in just that kind of research. From SKA and HESS to collaboration on the LHC to a proposed African Light Source, the time is right to build a robust program of outreach and education aimed at high school learners or undergraduates in universities or both. While we offer ideas based on current practices, we firmly recognize that the solutions for Africa, including engagement of African learners in physics, will properly come from the African physics and education communities. In this Letter of Interest, our goal is to enrich the conversation that leads to this development.

Two things that we have found to work well in engaging young people with both the excitement and the processes of physics as well as with actual physicists on a personal level are Physics Masterclasses and Cosmic Ray Studies. In the former, students come to a university or a laboratory to learn about cutting-edge physics, e.g., LHC experiments, from physicists and then engage in a measurement of actual experimental data. They finish the day with a videoconference with other groups who have made the same measurement and moderators from CERN or Fermilab. Going through this process, the students become "physicists for a day".

Cosmic ray studies are done in two ways. Students can assemble (if needed), calibrate, and then make measurements with cosmic ray detectors. Or they can use existing online cosmic ray data found in such resources as the QuarkNet Cosmic Ray e-Lab, HiSPARC, or the DESY Cosmic@Web. Often teachers work with their students in a combined approach. Students worldwide have opportunities to collaborate with each other in International Muon Week, sponsored by QuarkNet, and International Cosmic Day, sponsored by DESY.

We warmly invite African universities and laboratories to join in these and other existing efforts. These are primarily designed for advanced high school learners but we have found that they are beneficial for university students as well. Indeed, we do have university groups which join in International Masterclasses and Physics without Frontiers has done great work around the world bringing LHC masterclasses to undergraduates. More importantly, we would like to suggest that African universities and laboratories collaborate in connection to design and create an African outreach and education effort that can inspire and encourage high school and university students and their teachers by offering Masterclasses, Cosmic Ray Studies, and possibly other programs. Individual institutions can offer these in their locations and, to the extent practical, do so in connection with each other.

To stimulate such efforts, we envision the use of existing masterclass measurements based on experiments in which African institutions take part, such as ATLAS masterclasses for the LHC. We also would be excited to see the development of masterclasses based on research in Africa, for example, from HESS or the African Light Source. Such efforts would not only motivate students and teachers in Africa but would no doubt gain interest from around the world.

In a similar way, we encourage the development of a cosmic ray network among African institutions in which students can do research at their level and collaborate with each other. Others have recommended radio astronomy programs with small radio telescopes.

Realizing that cost is an important consideration, we note that many of these efforts can be accomplished using existing infrastructure and equipment or additional instruments with controllable costs. Cosmic ray detectors, for example, can cost thousands of U.S. dollars each or can be built for a few hundred dollars; cloud chambers can be even more inexpensive. There are trade-offs, of course, but learners and teachers can gain a lot by building, commissioning, and using even the least expensive equipment. And resourceful African teachers will sometimes substitute materials that their colleagues in other countries would never have thought of to bring the cost down and increase the accessibility even further while engaging students in a very fruitful design inquiry. (Some of us have seen this firsthand.)

We believe that development of these and other outreach and education efforts will help to sustain support for research and encourage young people toward careers in science and science-related fields in Africa. We look forward to working with others and developing these ideas into a white paper.

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