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# Building the SciBridge between Africa and the United States

*Veronica Augustyn and John Paul Eneku*

AFRICA, a continent of more than one billion people, accounted for less than 3 percent of global scientific publications in 2014.[1] The implications held by this single statistic are tremendous and include, in addition to growing economic inequality, the glaring scientific knowledge gap between the developing and the developed world. Coupled with this inequality are increased energy demands, just as the environmental effects of fossil fuels become more pronounced. It was in this context that, in 2012, we—while graduate students in our respective countries—had the unique opportunity to attend the first ever Joint U.S.-Africa Materials Initiative (JUAMI) research school on materials for sustainable energy in Addis Ababa, Ethiopia. The research school provided the means to bring together young scientists from the United States and East Africa, an unlikely event without external support. Over a period of two weeks, we learned about the latest scientific breakthroughs in materials for technologies ranging from solar cells to fuel cells to batteries. Staying and attending workshops at the same hotel meant that in addition to the scientific knowledge, we had many chances to learn from each other. After each day's seminars and lectures, we broke up into small groups for problem-solving exercises, which ranged from word problems to hands-on activities such as building a dye-sensitized solar cell. Working in teams, we wanted to ensure

*Veronica Augustyn is an assistant professor of materials science & engineering at North Carolina State University.*

*John Paul Eneku is a lecturer of physics at Makerere University in Kampala, Uganda.*

that each member understood the problem as well as the ultimate solution. It was evident that all the students present had a sincere desire to understand the physical and chemical phenomena that control materials' ability to harvest, convert, and store energy. Our time in Ethiopia culminated in a soccer match complete with a rallying cry adapted from a lecture we had attended on electrochemical technologies: "Play like a supercapacitor! Fast charge! Fast discharge!"

The challenge for the students upon "graduating" from the JUAMI research school was to continue working together in the future. Our time at JUAMI showed all of us how little interaction our respective research groups and universities had with scientists in Africa or the United States. Our successful experience at JUAMI, of working together and discussing critical issues regarding materials for sustainable energy, motivated us to develop a project that would enable more U.S. and African scientists to have this experience. Our task was to figure out how graduate students can successfully collaborate with each other across continents, without much authority to make decisions for our respective institutions and, most important, with no funding. This letter from the field describes our experiences—in the United States and Africa—in building up SciBridge, our effort to bridge the gap between scientists working in Africa and the United States.

At the end of JUAMI, both authors wanted to create a platform to develop Africa-U.S. research collaborations. One of the main reasons our project survived many setbacks was probably because we work so well together—we tried to be flexible, we believed deeply in the project, and we brought different talents to the table. In the beginning, when we did not have any funding, we knew that a true research collaboration would be difficult. Instead, we utilized the concept of low-cost experiment kits developed by the High School Nanoscience Program of the University of California, Los Angeles California NanoSystems Institute (UCLA CNSI). The idea was to use hands-on experiments to open up discussion, via webinars, between African and U.S. researchers and students on current topics in materials for energy. The SciBridge project began in August 2013 with one donated experiment kit to Uganda's Makerere University on solar cells from the UCLA CNSI program, but no money to manage project activities or send more kits. Everything moved slowly and we had trouble doing even the simplest things. For example, to make the donated experiment kit usable, we needed to send a titanium oxide sample to Kampala using our own money and thus the cheapest shipment option. The sample was inevitably lost, and we gave up trying to find it after three months.

We kept planning anyway and, in December 2013, we had the great opportunity to meet again in Africa and present our idea for SciBridge to attendees of the Africa Materials Research Society conference. The audience response was tremendous and included a suggestion to apply for a research grant from the Materials Research Society (MRS) Foundation, which we did upon returning to our respective countries. Being able to meet face-to-face and receiving encouraging responses

from the conference attendees galvanized us to continue our effort. Months went by and we maintained hope that SciBridge would be funded somehow. In April 2014, about nine months after starting the project, we received the fantastic news that we had received a "Grassroots Grant" from the MRS Foundation. We were ecstatic—finally, we had the means to pursue our project. The next few months consisted of working with the University of Texas, Austin, (UT Austin) administration to set up and manage our funds in the United States. In July 2014, we began assembling our first ten experiment kits on dye-sensitized solar cells with the help of undergraduate and graduate students as well as postdocs at UT Austin.

Shipping the materials to Uganda entailed a learning curve—our first experiment kit was stuck at customs for more than a month. In time, we learned the correct process for sending kits, which was facilitated by our engagement in university-to-university collaborations. The kits we sent to Uganda, for example, were accompanied by a letter stating that the items were for research and training of students and not for sale or resale. It was also critical that our kits were inexpensive, considering that, depending on the country, items costing more than $25 to $50 could be taxed.

Once the experiment kits arrived in Uganda, one of the authors (Eneku) personally visited each of the six Ugandan universities involved to kick-start project activities. It was an excellent opportunity to traverse the country but required a lot of endurance. Official responsibilities at Makerere University had to be juggled with the time needed for travel, typically two days per university—one day set aside for bus travel, the second day for the workshop, as planned beforehand with the host university. The different universities, whose audiences comprised undergraduate physics students as well as some faculty, welcomed and greatly appreciated the efforts of the SciBridge project. The participants were very excited by the prospect of academic interaction and exchange with U.S. universities. Moreover, the African SciBridge universities recognized that their institutional advancement in scientific research was way behind. They were not involved in cutting-edge research like their sister universities in developed nations such as the United States. They lacked financial resources to invest in elaborate scientific research. In addition, these institutions lacked global experts to champion scientific knowledge. Such experts must instead do what they can with limited scholarships to enhance their credentials by performing research at universities in developed nations. The SciBridge idea of providing high-tech experiments relating to the latest scientific research would directly help fill their respective universities' large knowledge and technology gaps. This was indeed a small step, but it was a step in the right direction.

The workshop's best moment for all participants was the hands-on experiment. They were excited by the innovation of making a solar cell with a mere fruit dye. Moreover, even despite the absence of teaching and research in the field

of dye-sensitized solar cells, students and faculty were able to draw on their academic backgrounds to understand the basic science and processes involved. In performing the experiment, they appreciated the need for further scientific innovation. With the experiment kit at their disposal, students and their lecturers were eager to investigate the potential of thousands of natural dyes—found in their local environments—for solar cell applications. Once we understood the students' eagerness to move beyond the experiment procedure and make their own investigations, we decided to send additional supplies to support individual research projects. We recently received news that students at some of the Ugandan SciBridge universities were utilizing the additional supplies for both bachelor's and master's degree theses. This was fantastic to hear because it aligns with the SciBridge project goal of enabling African students to innovate in their home countries.

A major component of the SciBridge project is for the African students to attend a live webinar on a current research topic relevant to the hands-on activity they just performed so that they can discuss the topic with a U.S. researcher. Our first webinar was held at Makerere University with a speaker from Pennsylvania State University. The speaker, a graduate student named Nella Vargas-Barbosa, did a tremendous job of discussing the latest developments in dye-sensitized solar cells, and the students were very focused and motivated by the presentation. The webinar, however, was delayed by about an hour owing to Kampala's Internet-connectivity issues. Although the students and speaker waited patiently for the connection to be established, it was dark outside by the webinar's end, when the students had to walk or catch buses home. The time difference and especially poor Internet connectivity have been major hindrances to hosting webinars at other universities; unfortunately, several sessions have been canceled over this issue. When recruiting speakers, we make sure they understand that the commitment requires a lot of flexibility as the seminar may be canceled at the very last moment. Amid weak Internet coverage across Uganda, universities themselves cannot afford a reasonable bandwidth to carry all the university's Internet traffic, with international videoconferences suffering particularly as a result. Independent Internet services, which provide a faster connection, are available but they are very expensive.

Over a ten-month period spanning from 2014 to 2015, SciBridge volunteers sent twenty-five kits to nine different universities in three different countries—with two Tanzanian universities and one Ethiopian university joining the six in Uganda. All three countries are among the world's least developed and are located in East Africa. They have high population growth rates and a significant number of teenagers who need educational opportunities. Because of limited government funding, universities in these countries do not have advanced basic training and research technology or expertise. The several challenges in administering SciBridge activities include variations in the three national educational systems,

resulting in differences in students' academic discipline or level. As this relates to the experiment, students and their instructors must have an appropriate scientific background in order for it to work. This is because we currently have no resources to cover travel funds for a workshop leader to visit each university. In Uganda, the educational background of both students and faculty in the field of solar cells has been good, and our target students have been physics undergraduates.

Thus far, we have learned that patience, flexibility, and persistence are key factors in ensuring that this intercontinental project survives and succeeds. Our future plans are to continue with our workshops on dye-sensitized solar cells as well as on aluminum air batteries, for which project volunteers recently developed a new experiment kit to demonstrate electrochemical energy technologies, to be held at universities in Uganda, Ethiopia, and Tanzania.

We hope to develop connections and partnerships with other Africa-based science, technology, engineering, and math programs aimed at developing the science and engineering workforce, as well as inspire more U.S. universities to engage with African universities. The enthusiasm of African student participants in our workshops is contagious. One bit of anonymous feedback on the experiment kits was this: "It was the most interesting workshop that I have ever attended. I liked all that I was given, and am more interested in doing my further studies in dye-sensitized solar cells." Within the area of materials research, relatively few Africa-U.S. collaborative networks are now in place. Once told about the SciBridge program, however, many U.S. students and scientists are keen to participate. Interest appears to be particularly high among researchers in sustainable energy, who are eager to discuss their technologies with scientists in developing countries, where the technologies may be first adapted in new, modern power grids.

With our first grant's expiration at the end of May 2015, we are looking for funding opportunities to develop new hands-on experiment kits. We recently received a grant from North Carolina State University (NCSU) that will enable us to develop ten new experiment kits in spring 2016. This grant will also be used to recruit underrepresented minority students to the College of Engineering at NCSU. A recent study published in *Science*[2] demonstrated that women and African Americans are underrepresented in fields, including physics and engineering, in which practitioners believe that innate talent is the main indicator of success. We will showcase a different aspect of engineering by highlighting its international, collaborative, and societal impacts. Moreover, we are exploring ways of enlisting instrument companies to donate equipment to our African partner universities, as the lack of equipment is a key hurdle for experimental materials science research in Africa. We recently received a generous instrument donation from Ocean Optics that will allow Makerere University students to characterize the absorption properties of local berries to investigate new dyes for dye-sensitized solar cells. Lastly, we developed a quarterly newsletter to connect all our current and former participants, as well as anyone interested, with the latest SciBridge

news, international fellowship and funding opportunities, and developments in sustainable energy research and development, particularly in Africa.

The SciBridge project began as an idea between two graduate students who met at the first JUAMI research school in Ethiopia. It was facilitated by understanding faculty advisors, flexible university administrators, a grant opportunity that was open to students, and the time and dedication of fellow university students and lecturers. Recently, NCSU and Makerere University signed a memorandum of understanding to formalize a strategic partnership and enable the exchange of ideas, students, faculty, and visiting scholars. This official institutional support will help the project substantially because it leads not only to increased administrative support but, critically, to access to internal grant funding specifically set aside for collaborations between NCSU and East African universities. This is a powerful signal to faculty that the university welcomes such collaborations.

We urge U.S. scientists, particularly those working in sustainable energy, to become involved in Africa-U.S. science collaborations. The greatest engineering challenge we face is the need for secure and sustainable global energy. Many countries in sub-Saharan Africa are just beginning to develop their electrical power infrastructure, coming at a time of increased effects of climate change and population growth. Universities in Africa, including our SciBridge partner universities, are filled with students in need of educational and economic opportunities. We need to enable the education of these students so that they can work and pursue innovation in their countries, including the huge task of bringing electricity to sub-Saharan Africa. Funding for such collaborations is available from the U.S. federal government, including the U.S. Agency for International Development and the National Science Foundation. Professional societies, individual universities, and companies can also be tapped for financial support. We are very excited and grateful for the support we have received thus far for SciBridge. We look forward to continuing our SciBridge efforts and always welcome new ideas and participants. SD

**Endnotes**

1. *UNESCO Science Report: towards 2030* (Paris: United Nations Educational, Scientific and Cultural Organization, 2015).
2. Sarah-Jane Leslie et al., "Expectations of Brilliance Underlie Gender Distributions across Academic Disciplines," *Science* 347, no. 6219 (January 16, 2015): 262–65.