PASEA: An Experiential Short Course in Astronomy for African Students

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The Pan-African School for Emerging Astronomers (PASEA) is an experiential short course in astronomy for African university students, designed and taught by a team of scientists from Africa and around the world, using educational research principles. First held in 2013, the biennial school is designed to offer African science students the opportunity to inspire their scientific curiosity and interest in astronomy, enhance their scientific practices, and receive guidance for careers in science, technology, engineering and mathematics (STEM). It also offers instructors the opportunity to exchange educational ideas internationally and build skills for teaching scientific thinking. PASEA thus aims to benefit society by supporting the development of scientific leaders in Africa, with astronomy as a gateway. PASEA was born from a discussion between astronomers from Nigeria and Canada at the 2012 International Astronomical Union General Assembly in Beijing.

The most recent school was held October 21 – November 1, 2019, hosted by the Centre for Basic Space Science (Nsukka, Nigeria) and held at the National Space Research and Development Agency (NASRDA) in Abuja, Nigeria. It was organized and taught by scientists from 12 institutions across four continents[i]. Previous schools were held in 2017 (Accra, Ghana), 2015 (Nsukka, Nigeria), and 2013 (Abuja, Nigeria). PASEA is formerly known as WAISSYA: the West African International Summer School for Young Astronomers. Building on the success of four schools and interest from students beyond West Africa, in 2019 we decided to expand our program across Africa to become PASEA. PASEA 2021 will be held in another region of Africa; we are currently seeking proposals from interested host institutes.

This is a special time in history for African astronomy, thanks to the establishment of three new African Regional Offices of Astronomy for Development, and the building of new radio astronomy facilities across Africa to complement the global Square Kilometre Array Project. These investments provide significant momentum towards developing a strong astronomy community in the region, at the same time also advancing related STEM fields. To leverage this opportunity, the large number of talented African students interested in science need experiences that inspire them to pursue astronomy or related STEM careers, and that help them develop scientific community with their peers. PASEA was created to be such a program.

Several crucial aspects of PASEA make the program unique: (1) the multi-national nature of our collaboration, (2) the teaching strategies we use, and (3) the ways we assess the effectiveness of the program. Science summer schools typically are taught by a team of foreign instructors who make only a short-term commitment to the program, perhaps just the duration of the school. Their instructors typically do not receive professional development in teaching, teach mostly via traditional lecture, and assess the success of the school only via surveys of student satisfaction. By contrast, about two-thirds of the PASEA team are African astronomers, and the whole team makes a multi-year commitment to the program. This is crucial to ensure our program is driven by the goals and local contexts of African scientists, not those of foreigners. PASEA's approach to teaching also stands in contrast to those of other summer schools. A large body of research on how students learn science indicates that interactive teaching methods are much more effective than traditional lecture[ii], centers the teaching of scientific thinking along with scientific content[iii], and emphasizes supporting students to develop their identities as scientists[iv]—especially crucial for students from underserved backgrounds[v]. We have developed PASEA's curriculum and instructor professional development to incorporate these research-based best practices. The capstone of the PASEA undergraduate curriculum is a two-day inquiry lab in which students ask

their own questions about astronomical objects and work in teams to investigate solutions to their questions. Students also learn about astronomy topics via interactive lessons, discuss astronomy careers and challenges facing women in science, and develop an astronomy outreach activity for their local communities. A parallel postgraduate stream focuses on astronomical research via computer programming and a project with a robotic telescope. After the in-person program ends, we continue the PASEA community via a Whatsapp group for alumni (120 members, dozens of messages per week) and an online career mentorship program we are piloting to support alumni.

To help PASEA instructors develop their interactive teaching, we hold an instructor workshop the week prior to the summer school, and we organize instructors into international pairs to co-design and co-teach interactive lessons together. Research in other contexts, including work by PASEA Co-Director Strubbe,[vi] has shown that co-teaching can support newer instructors in learning and incorporating interactive teaching strategies into their future courses. This is an important time for the team to work together in person, since most prior interaction is conducted remotely. Team members also spend a day engaging in astronomy outreach in local schools.

We endeavor to measure the effectiveness of the PASEA summer school experience via standard surveys on scientific beliefs and astronomy content understanding, and qualitative measures like student reflections. We have repeatedly found that students' beliefs about science become significantly more sophisticated during the program—a rare achievement[vii].

In a recent survey of PASEA alumni, 90% said PASEA was very influential for their choice of career or studies. Half of our alumni teach or work in STEM; twenty alumni are in STEM graduate school and postdoctoral positions in Canada, South Africa, and other countries. Three-quarters of alumni say PASEA influences how they teach; their students number in the thousands and will keep growing. Alumni also create outreach initiatives: e.g., alumni in Ghana created astronomy clubs at 7 schools with 400 student members. PASEA instructors also bring inquiry to their regular teaching: e.g., one team member transformed his physics course in Nigeria and presented at an international conference. We are delighted that four alumni have joined the PASEA instructor team—two of whom are now pursuing astronomy Ph.D.s at the University of Toronto. One alumna wrote that PASEA "opens the mind to bigger pictures of what the universe is all about … There was a sense of togetherness, regardless of our different backgrounds."

We are excited to build on the success of PASEA as we envision how our program can expand and grow. Our team (now more than 20 strong) has wide ambitions including spreading the program to other parts of Africa; building our piloted online mentorship program; supporting more alumni to become PASEA instructors; expanding our public outreach; offering more workshops on inquiry-based teaching (e.g., for local faculty and for PASEA students themselves); and publishing PASEA research—both astronomical research from the post-graduate stream, and educational research on teaching and learning in PASEA.

Since 2013, through four successful schools, PASEA has so far provided a formative scientific experience for more than 250 African students, strengthening students' abilities to investigate scientific questions, building their interest in astronomy and related STEM careers, and supporting alumni to pursue graduate studies. PASEA's focus on inquiry and instructor professional development can serve as a model for programs in other parts of the world. Now as our program looks to the future, the passion and motivation of our students inspire us to keep moving forward in supporting the continued growth of the scientific community in Africa.

[i] Centre for Basic Space Science (CBSS, Nigeria), National Space Research and Development Agency (NASRDA, Nigeria), University of Nigeria Nsukka, Ghana Space Science and Technology Institute, Ghana Planetarium, University of South Africa, North West University South Africa, American Association of Physics Teachers, Dunlap Institute for Astronomy and Astrophysics, University of Toronto, Oxford University / Swinburne University, and Université Le Havre. Team members come from and/or work in Africa, Asia, Australia, Europe, and North America.

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