OPINION
Developing Science Communication in Africa: Undergraduate and Graduate Students should be Trained and Actively Involved in Outreach Activity Development and Implementation

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Despite recent improvements in scientific research output from Africa, public understanding of science in many parts of the continent remains low. Science communication there is faced with challenges such as (i) lack of interest among some scientists, (ii) low availability of training programs for scientists, (iii) low literacy rates among the public, and (iv) multiplicity of languages. To address these challenges, new ways of training and motivating scientists to dialogue with non-scientists are essential. Developing communication skills early in researchers' scientific career would be a good way to enhance their public engagement abilities. Therefore, a potentially effective means to develop science communication in Africa would be to actively involve trainee scientists (i.e., undergraduate and graduate students) in outreach activity development and delivery. These students are often enthusiastic about science, eager to develop their teaching and communication skills, and can be good mentors to younger students. Involving them in all aspects of outreach activity is, therefore, likely to be a productive implementation strategy. However, science communication training specifically for students and the involvement of these students in outreach activity design and delivery are lacking in Africa. Here, we argue that improving the training and involvement of budding scientists in science communication activities would be a good way to bridge the wide gap between scientists and the African public.

Key words: Science communication, science outreach, public engagement in science, science literacy, Africa

Recent advances in science, technology, engineering and mathematics (STEM) have led to important findings that are relevant to African communities. Examples can be found in public health, sanitation and biotechnology-based agriculture (United Nations, 2009; Adenle, 2011; Giné-Garriga et al., 2013; Okeno et al., 2013). These advances are increasingly being applied to develop tools and techniques to help improve the quality of life, accelerate economic development and boost industrialization (Karikari, 2015). For example, it was reported in the *African Innovation Outlook*, following an analysis of scientific growth indicators in selected countries, that research productivity had improved in many countries (NEPAD Planning and Coordinating Agency, 2014). Similarly, The World Bank reported that many sub-Saharan African countries had advanced in their STEM productivity over the last decade (The World Bank, 2014).

However, the public's understanding of science has not increased correspondingly with the recent growth in scientific knowledge output. To ensure that STEM advances are better understood and accepted as potential solutions to developmental challenges, it would be necessary to promote closer scientist-public interactions. Members of the public fund research through their taxes, participate in research as subjects, and are the ultimate consumers of research discoveries. Scientists should therefore devise simple, easy-to-understand mechanisms of ensuring that scientific findings reach the public in ways that they (the public) will comprehend.

HOW BENEFICIAL WOULD IMPROVED STUDENT INVOLVEMENT IN SCIENCE COMMUNICATION ACTIVITIES BE TO AFRICA?

Effective science communication involves activities that promote dialogue, build relationships and trust, and engage participants (Nisbet and Scheufele, 2009). As such, real progress in science literacy will entail more systematic training for scientists to engage with the public (Anon, 2009). Hence, a potentially viable approach to develop and sustain science communication efforts would be to develop these skills early in a researcher's scientific career. The future of public engagement rests largely on the active involvement of the next generation of scientists. For this reason, leading scientific societies, including the American Association for the Advancement of Science, have advised that these students should be trained to be able to effectively communicate science to non-scientists (AAAS, 2011). Consequently, a number of successful student-led outreach training programs has been established (McQueen et al., 2012; Brownell et al., 2013; Fitzakerley et al., 2013; Devonshire et al., 2014; Goldina and Weeks, 2014; Kuehne et al., 2014). Young scientists are usually enthusiastic about science, keen to share their

experiences with the public, and can also be good mentors to younger students (Laursen et al., 2007; McQueen et al., 2012). Involving them in all aspects of outreach activity is, therefore, likely to be a productive implementation strategy. Yet, reports on the training and/or involvement of students in outreach activities in Africa are lacking.

We define student-led outreach as science communication activities in which trainee scientists are actively involved in the design and implementation. A common feature of this concept is that students take active part in initiating outreach projects, designing and implementing activities, collecting and evaluating participant feedback, and sharing outcomes with the wider public. This usually happens under the supervision of faculty members or senior students. Student-led outreach activities are either integrated into curricula or are offered as extracurricular assignments. These schemes have been used successfully outside Africa to achieve various outreach goals (Beck et al., 2006; Laursen et al., 2007; Stevens, 2011; Devonshire et al., 2014; Goldina and Weeks, 2014). While student-led outreach is not new, activities of its kind are lacking in many African countries. We believe that adapting the concept to the African setting could help to develop science literacy by training ambassadors who would promote the advancement of innovative public engagement solutions.

The potential benefits of student-led outreach activities to Africa can be categorized into two. Firstly, it would motivate the scientific community for greater outreach by allowing instructors to integrate science communication training into their teaching. Secondly, it would be a good means to reach out to the future generation of professionals, preparing them for public engagement in their chosen careers.

Motivating the Scientific Community for Outreach

While many scientists in Africa acknowledge the importance of science communication, participation in such activities remains low (De Mulder et al., 2014). Many reasons have been given for this, including the perception of outreach as a secondary role in research, low availability of resources for engagement, time constraints and a lack of institutional support and reward for scientists who engage in outreach (The African Technology Policy Studies Network, 2010; Kaye et al., 2011; De Mulder et al., 2014). While many universities in the United Kingdom, for example, have signed a *public engagement manifesto* and have established widening participation offices to support outreach activities, such initiatives are lacking in many African countries (National Co-ordinating Centre for Public Engagement, 2010; Devonshire and Hathway, 2014). Nonetheless, some African governments and research organizations do appreciate the importance of science communication and have developed various approaches to promote it. An example is the introduction of open access publishing policies to improve visibility of, and access to, research conducted on the continent (Matheka et al., 2014).

Despite the foregoing measures, the public's understanding of science in Africa seems not to have improved much. A plausible explanation would be that making scientific publications full of discipline-specific terminologies available to the public is not likely to make significant impacts in enhancing science literacy. A large proportion of the African populace lack formal education (UNESCO Institute for Statistics, 2010). Besides, many of the people with considerable formal education are computer-illiterate. Both sets of people may either not know how to access scientific information on the Internet or lack the resources to do so, let alone understand it. More effective public engagement approaches must, therefore, be developed for specific communities.

Many scientists complain that they have limited or no time for outreach due to burdens at the workplace resulting from understaffing, high teaching loads, administrative responsibilities, and the regular application for research funding (Kaye et al., 2011). To address this challenge, student-led outreach would allow faculty members to take an active part in science communication activities by supervising student-led projects without necessarily partaking in the entire activity design and implementation (Stevens, 2011). With appropriate training and supervision, students can lead outreach activity development and delivery. For example, Beck et al., (2006), Foy et al., (2006), MacNabb et al., (2006), McQueen et al., (2012), Devonshire et al., (2014), and Goldina and Weeks, (2014) have successfully utilized this model to reach out to school children, teachers, and community groups about science. This approach has allowed students to take lead roles in science communication, enhancing their leadership, networking, teamwork, and communication skills.

Reaching Out to the Next Generation of Professionals

By regularly interacting with the public, students considering future research careers would obtain firsthand understanding of what the public expects from scientists and how these expectations can be addressed. This experience would be instrumental in bridging gaps between science and society. For example, Goldina and Weeks (2014) successfully developed a science café course to train undergraduate students to apply their scientific knowledge to develop and host outreach activities covering contemporary topics such as cancer, nutrition, and stem cell therapy, helping to identify public opinion on these topics. Another illustrative example was provided by Zardetto-Smith et al. (2006) who showed that leading an exposition targeted at school children built the professional skills of neuroscientists, enabling them to develop effective ways of explaining neuroscience information to the public. In an era where the ethical, legal and social implications of research are becoming more integral components of the research process, regular public engagement would ensure that societal expectations are appropriately considered in scientific investigations. This is particularly important in Africa where ethical guidelines are not always available or followed and the rights of study participants have sometimes been abused (Amon et al., 2012; Wright et al., 2014).

In addition, the establishment of student-led outreach

schemes would serve as a medium to reach out to the future professionals with whom scientists will collaborate in the discharge of their duties. Not all students trained in the sciences will go on to become scientists; some (possibly the majority) will go into careers in areas such as healthcare, science journalism, and education. Scientists are likely to collaborate with these professionals: whether for the purposes of research or outreach. Early introduction of these future professionals to outreach training would enable them to simplify complex information for public use.

POTENTIAL CHALLENGES IN IMPLEMENTING STUDENT-LED OUTREACH ACTIVITIES IN AFRICA

Here, we discuss potential challenges in the adoption of the student-led outreach approach to science communication, and suggest practical strategies for addressing them.

Possible Burdens for Faculty Members

Increasing participation in science communication activities is likely to add to the existing workload of faculty members. Although students are expected to lead outreach activity development and delivery, their instructors will have to commit time to, for example, train students, supervise projects, provide feedback, and assess grant applications and project proposals. Although these tasks constitute a time commitment, they form a smaller commitment compared to what goes into developing and implementing outreach projects all by an individual (Stevens, 2011). Faculty members may address this challenge by seeking support from their colleagues, teaching assistants, or senior students in executing these functions. Additionally, faculty members may be awarded teaching credits for the outreach training and mentoring they provide, as done elsewhere (Stevens, 2011; Devonshire and Hathway, 2014). This would encourage scientists to contribute to outreach without spending much more time beyond their teaching load. Many programs of this kind have been successfully introduced elsewhere (Stevens, 2011; Brownell et al., 2013; Devonshire and Hathway, 2014; Devonshire et al., 2014; Goldina and Weeks, 2014).

Training Students to Develop and Host Outreach Activities

The success of an outreach activity depends on its design, implementation and evaluation. Student-led outreach is no exception. Training students to interact with the public can be a difficult task. To overcome this, students may be best trained by involving them directly in the design and delivery of real-world outreach activities. A *shared responsibility* model can be employed to provide training in the different aspects of outreach development and implementation. For example, students could be grouped into sub-teams such as those responsible for: developing and delivering the outreach activity, obtaining and analyzing participants' feedback, and coordinating activity organization. Students may be occasionally rotated between the sub-teams, providing them with the opportunity to learn from different roles.

CONCLUSION

Budding scientists can be used as agents of change in science communication in Africa; as ambassadors who lead efforts aimed at increasing scientist-public interactions (see Yawson et al., 2016, this *JUNE* issue). Although not all students in the sciences will pursue careers in research, success in their chosen professions will depend largely on excellent communication skills. Equipping them for effective public engagement should, therefore, be beneficial to their future professional endeavors. In addition, student-led outreach provides the unique opportunity of allowing faculty members to contribute substantially to outreach activities without necessarily partaking in activity delivery. This would provide a time-effective approach that relieves faculty of the time burden involved in running outreach activities. It would also provide students with the opportunity to develop key transferrable skills through their interaction with the diverse African public.

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