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Unlocking open science in Africa: Mentorship and grassroot community building

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Abstract. Open Science is becoming increasingly popular among scientists worldwide, but African researchers have hesitated to adopt it. This keynote speech addresses the current state of open science in Africa and the challenges researchers face in implementing open science practices. As an open science advocate and mentor in Africa, I share my experiences and discuss the role of mentorship and grassroots community building in overcoming these challenges. Various initiatives, such as OpenScienceKE, H3ABioNet, and BHKi, aim to increase awareness, empower members, and encourage collaboration to promote open science, information sharing, resource sharing, and the visibility of African research. It is essential to involve all stakeholders within local communities and empower grassroots communities. Like planning for a mountain climb, providing the necessary support to facilitate success is crucial. The article highlights the importance of inclusivity and support to overcome barriers and challenges to reap the benefits of open science. I show how culture changes towards openness, breaking down barriers, empowerment, allyship, and grassroots community building are pathways to achieve this change.

Keywords: Open Science, Africa, research collaboration, mentoring, grass roots communities, OpenScienceKE, H3ABioNet, BHKi

1. Introduction

In resource-constrained settings, such as African academic institutions, a common scenario arises for academics and students engaged in research. They may come across abstracts that hold the potential to address their research questions, only to find them behind paywalls [1]. Alternatively, they find data or results that could complement their research, particularly when financial constraints prevent them from generating sufficient data. These scenarios highlight the crucial importance of Open Science, especially for researchers operating within limited-resource contexts. The principles of Open Science encourage transparency, collaboration, and unrestricted access to research output and resources. By adopting these principles, researchers can freely access and use research articles, datasets, methods, code, and other research findings, without worrying about financial barriers [2]. This is particularly important for African researchers, who encounter many challenges in pursuing scientific progress. Barriers to adopting open science include a lack of awareness, training, and support infrastructure [3]. In this article, I argue that the

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pathway towards adopting open science principles should be driven by researchers within the communities who understand the challenges and are motivated to create change. I show the growth in research in Africa and how mentorship and grassroots community building are pathways towards the wider adoption of open science principles.

2. Africa is rich but highly-exploited and has low visibility of output

Focussing on research data sharing is essential, but we must also address the incorrect notion that Africa produces very little research in various fields. The truth is that much African research is not easily discoverable, and the actual percentage could be much higher than the estimated 0.1%. Unfortunately, there is not enough discussion about how to make the research output of this region more discoverable. African scholars often list their European partners as their affiliation or publish in local journals that are not indexed, making it difficult to find their work [4]. One major issue is the limited sharing of open data, demonstrated by the Open Data Parameter in 2016 [5]. Many regions in the global South, including Africa, have low data sharing rates.

Africa has numerous valuable natural resources, such as minerals that are extracted from the region and are used globally, with little benefit to the local economy. This extractive economy is not limited to minerals and agriculture but includes scientific resources, which Africa has plenty of as the cradle of humanity with rich biodiversity. The concept of helicopter research, in which research in impoverished countries solely focuses on extracting data or samples without respectful collaboration, is prevalent [6]. Helicopter research leads to missed opportunities for collaboration with researchers in the region who understand the challenges; the questions and research that could have been conducted remain unanswered. We argue that African science is essential not only for the benefit of African people, but also for advancing science globally. Therefore, conducting scientific research in areas most affected by diseases is crucial, focusing on addressing specific research questions unique to those regions. Although it may have been said that only a little was happening in Africa some years ago, many research initiatives are now generating data and scholarly output in the region.

Over the years, there has been an advancement in genomic research in Africa with initiatives such as H3Africa [7], funded by Wellcome Trust and the National Institutes of Health (NIH). These initiatives have increased the amount of genomic research generated and analyzed in Africa, with the capacity developed through H3ABioNet [8] to enable genomic data analysis by African researchers across the continent. When the Covid pandemic hit, Africa was much better prepared to adopt genomics to track the spread and emergence of new variants with additional capacity being developed through the Africa CDC [9,10].

3. We are seeing increased funding and African-driven publishing

In addition to externally funded initiatives, we see more funding initiatives driven by Africans. One positive initiative is the Regional Scholarship and Innovation Fund (Rsif) that is hosted at the International Centre of Insect Physiology and Ecology, which manages direct funding from African governments for PhD and MSc research in applied sciences and engineering across Africa [11]. The Science for Africa Foundation [12] supports the Open Research African Publishing Platform [13], a new initiative to fund African researchers to address critical issues that impact people in Africa. This platform is helping to promote research funding within the continent.

We also observe African-driven initiatives to increase the visibility of African research output. For example, AfricArXiv is a pre-print server that publishes research outputs and indigenous knowledge [14]. Information needs to be digitised from archives and hard copies in libraries to increase the visibility of African research. The Training Center in Communication, led by Africans within the continent, is taking initiatives to increase the visibility of African research and adopting tools that facilitate this through the PID Alliance [15].

4. Defining Open Science

There are many definitions of open science, each with its nuances. "Open means that anyone can freely access, use, modify, and share for any purpose (subject, at most, to requirements that preserve provenance and openness) [16]." https://opendefinition.org/. UNESCO argues that "open science is defined as an inclusive construct that combines various movements and practices aiming *to make multilingual scientific knowledge* openly available, accessible and reusable for everyone, to increase scientific collaborations and the sharing of information for the benefits of science and society, and to open the processes of scientific knowledge creation, evaluation, and communication to societal actors beyond the traditional scientific community [17]". In Wikipedia, "*Open science* is the movement to make scientific research (including publications, data, physical samples, and software) and its dissemination accessible to all levels of society, amateur or professional". It has also been defined as the movement to make scientific research, data and their dissemination available to any member of an inquiring society, from professionals to citizens [18]. It "is transparent and accessible knowledge that is shared and developed through collaborative networks [19]".

UNESCO emphasises Open Science as an inclusive construct that makes multilingual scientific knowledge openly available. However, most scientific publications are in English, although there are more than forty ethnic languages in Kenya alone [20], for example. So, what does open science mean in different contexts, for example, in the global South, and what are the pathways for its adoption? It is worth mentioning that much of African knowledge has been transmitted orally through storytelling, music, and dance [21]. This raises the question: how can publishing and research sharing adapt to enable sharing through these channels, allowing more communities with a stake in the research to access it?

5. Going beyond open access publications

It is worth noting that publishing is just one aspect of research, and a significant amount of time, effort, and resources go into it. Researchers produce other outputs, such as data, lab work, protocols, interviews, community engagement, citizen science, and initiatives to reduce poverty and disease within their communities. These outputs should also be considered by the reward systems [22]. All of this work is happening, but it is not regarded as traditional research output, which is publication. It is crucial to facilitate the visibility of these other aspects and increase their sharing.

Open science commonly includes open-access publishing, which involves different methods to make research findings accessible. The green route involves authors depositing their publications in open repositories, while the gold route involves publishing in open-access journals [23]. It is important to note that open-access publishing is just one component of research output. As Beckett and Donahoe point out, "*An article (about computational result) is advertising, not scholarship. The actual scholarship is the full software environment, code, and data that produced the result"* [24]. To fully embrace science, we

must acknowledge that it encompasses more than just publishing findings. Science involves a researcher's entire process, including data collection, interviews, community involvement, protocol and methodology development, and other efforts. These contributions represent a scholar's dedication to science and should be recognized and incentivized, focusing on promoting the sharing of all research outputs, not just publications. It is crucial to ensure that these contributions are visible and acknowledged.

Below, I will highlight some essential elements of science and scholarly contributions, highlighting some barriers in resource-constrained settings and pathways to increasing adoption.

Open research data: Sharing open research data is vital for others to verify or reuse research findings. Nonetheless, sharing data in resource-constrained settings where data is valuable can be challenging. Fortunately, there are platforms such as Zenodo, Figshare, and Dryad where researchers can store and share their research output openly. Despite these available platforms, there are still barriers to adopting open science practices, especially in resource-constrained settings. One challenge is the lack of awareness of such platforms, the skills for preparing resources for sharing, and where there are charges and funding. In addition, managing data and sharing them with proper metadata and licences is a crucial aspect of scholarship. Mentorship and grassroots community building can help increase the adoption of these practices. By providing researchers with the necessary skills and support, we can overcome barriers to open science and increase the visibility and impact of their research.

Raw scientific materials, such as samples and specimens, are crucial components that should be adequately documented and shared [25]. The research lifecycle involves more than just the publication phase. Researchers, especially in Africa, who contribute to sample collection and management often go unrecognized due to the "publish or perish" mentality. This needs to change.

Software and code are essential to scholarly work [24]. However, preparing for sharing requires significant time and effort. Therefore, when this contribution is not recognised and incentivised, researchers may not be motivated to share their code or may do so without proper documentation or metadata.

To encourage more sharing of research outputs, we need to recognise and incentivise all aspects of the research process, not just publications. Proper documentation, metadata, and licencing are essential to ensure that data, code, and methods are FAIR: Findable, Accessible, Interoperable, and Reusable. All of these components are essential to open science, but the meaning of "open science" can vary depending on the context in which it is used.

6. Contextualizing Open Science

Academics in Resource-constrained countries face challenges due lack of policies and institutional support, leaving them with insufficient funding and overworked schedules. Implementing open science, such as adequately documenting and sharing data and software, is an additional burden to these researchers. Therefore, it is essential to consider how we can facilitate the adoption of open science practices in these contexts. To increase the adoption of open science practices, we must consider building from the bottom up and understanding different communities' specific contexts and needs, particularly in areas with little top-down support. This approach focuses on students and early career researchers who face pressure to publish and may have more flexibility in adopting open science practices.

To ensure that open science practices are adopted within specific communities, it is essential to understand their unique needs. By designing locally owned and driven interventions, we can facilitate greater adoption of these practices. As a researcher, you must equip yourself and your collaborators with the tools and techniques of open science to be efficient.

To promote open science, we must raise awareness of new initiatives such as open access, open source, educational resources, and open data [3]. It is important to provide researchers with the tools and skills necessary to implement these practices, and this should be done in a way tailored to each community's needs. To make this happen, we must take a bottom-up approach and create a supportive environment where researchers can collaborate, exchange ideas, and share resources. Training in open science tools and practices is crucial for researchers to empower them and facilitate the adoption of Open Science.

Acknowledging and overcoming the obstacles that hinder researchers from embracing open science practices is crucial. These obstacles include insufficient funding, inadequate access to technology, and insufficient supportive policies and institutional frameworks. To promote open science practices, a comprehensive approach is necessary that considers the needs and circumstances of various communities.

After introducing the concept of open science, it is crucial to empower researchers with the tools to practice it. And it is not just about teaching the tools theoretically; it is also essential to create an environment where they can practice and understand the utility of such tools. To sustain this, community building is necessary through activities such as meetups and fireside chats.

7. Role of grassroots communities

Grassroots communities are essential in promoting the adoption of open science. They possess an in-depth understanding of the challenges and context and are locally owned and driven, resulting in increased acceptance of open science. In this section, I will briefly discuss some communities that drive local initiatives or support the growth of grassroots communities.

OpenScienceKE is a group of scientists, researchers and students seeking to promote open science practices in bioinformatics. The OpenScienceKE model focuses on empowerment and community building to ensure group growth. The younger generation can learn to drive change from the bottom by influencing their mentors.

Bioinformatics Hub of Kenya Initiative (BHKi), established by students and mentees from Eastern Africa Network for Bioinformatics Training capacity-building and mentorship activities, aims to raise a generation of globally competitive bioinformaticians from Kenya and Africa for the good of humanity and the natural world [26].

Open Learning Circles from H3ABioNet create communities within African nodes involved in bioinformatics. They create learning circles within these nodes to continue training and creating awareness within the local community. This grassroots approach effectively facilitates the adoption of open practices within communities.

Mentorship through the Open Life Sciences: Besides grassroots initiatives, we emphasise mentorship. I mentor my students and trainees to adopt these practices and build communities. Other structured mentorship programs, such as Open Life Sciences, have mentored leaders and created open leaders who can lead initiatives within their communities. Several communities above have been established or grown through open leadership mentorship programs. For example, the Research Software and Systems Engineers based in South Africa promote RSEs in Africa, the Open Science community in Nigeria and the BHKi in Kenya. All of these groups are grassroots communities that understand the needs within their communities and can tailor initiatives or create frameworks that facilitate the adoption of open practices. These mentorship programs provide them with the tools to create change within their communities. By creating ambassadors and mentors that become open leaders within their communities, we can create a critical mass that can ensure the adoption of these practices across the African continent. Training and

mentorship have played a crucial role in changing attitudes towards open practices and creating a culture of openness in African communities.

8. Hiking and community building

One passion of mine that has taught me a lot is hiking. We organise hikes and map trails in Kenya in different regions, looking for beautiful views and challenging trails. Although reaching the summit is always the ultimate goal, it is essential that others can do the same. In areas with low adoption or no existing trails, we become trail mappers, creating new paths that others can follow and enjoy the view from the top.

Similarly, we can apply this approach to open science. We can reap the benefits of sharing information, open data, and various research results, but ensuring that everyone can access these resources is also important. Science is collaborative, and we must work together to create an environment that facilitates open practices and ensures that all communities can benefit from them. By doing so, we can create a critical mass of open science ambassadors and leaders who can promote open practices and inspire others to follow in their footsteps.

So, like hiking, achieving open science should not be an individual effort. Instead, it should be a collaborative effort that involves creating a path or a trail for others to follow. We can achieve this by creating communities and mentorship programs that help spread awareness and understanding of open science practices. By empowering individuals with the tools and knowledge necessary to adopt open science, we can create ambassadors and open leaders who can spread the message. These grassroots initiatives can be tailored to the specific needs of different communities, and we can create frameworks that facilitate the adoption of open science practices within these communities.

Ultimately, the goal is not only to reach the summit ourselves, but also to create a path others can follow to reach the summit. Like hiking, the benefits of open science are best enjoyed when shared and accessible to everyone. By working together and building communities, we can ensure that everyone can reap the benefits of open science and collaborative research.

Achieving openness can be accomplished through various means, such as building awareness, enhancing skills, and offering training and mentoring. It is not limited to performing tasks on behalf of others or simply demonstrating how to do something; instead, it involves empowering individuals to become advocates and leaders within their communities.

9. Summary of lessons from hiking

9.1. More significant progress comes from community collaborations and working together

As we move towards the mountain, we must hold each other's hands and take advantage of the strengths of different initiatives. If a community is already doing it well, it is unnecessary to reproduce what they are doing. Some people are good at leading, while others provide training materials, project planning, management, mentorship, communication, and sharing. These communities have their strengths, and many other communities within and outside the continent are involved in promoting open science, open access, and open data and providing funding for all these initiatives. It is important to involve these communities and leverage the strengths of different initiatives to achieve our shared goal of promoting openness in science.

It is important to recognise the strengths and expertise that different communities bring to the table and to leverage those strengths to achieve a more significant impact in promoting open science, open access, and open data. It is not about replicating what others are doing but working together and building collaborations to achieve common goals. Furthermore, it is important to involve everyone within the team and empower individuals to be advocates and ambassadors within their communities. This can be achieved through capacity building, mentorship, and opportunities for individuals to take the lead within their communities.

9.2. Being inclusive and supportive

Being inclusive and supportive is essential, as many barriers and challenges exist. How can we involve all the various stakeholders within the local communities and build local and grassroots communities to ensure that we are fully aware of the intricacies within those regions we open by design and not by default? It is about openness, clarity, and planning. You must thoroughly plan when planning to climb a hill or a mountain. And when it comes to facilitating someone to climb the mountain, in the end, you have to provide the necessary equipment, such as hiking boots, hiking sticks, rain jackets, etc., to ensure that they are equipped to climb the mountain. This way, they can be warm as they climb the mountain and enjoy the view and the other side. If we become allies to the various communities, we create a pathway for others to follow. If you have reached the top of the mountain, it would be nice if you could map a trail for someone else to follow, making it easier for others to get to the mountain and enjoy the view at the summit. There is always a beautiful view for all of us.

9.3. Cultural change

To achieve greater representation and access to research, we must change the culture by breaking down barriers. This means addressing systems that limit collaboration, publishing, and funding opportunities for specific communities. We can encourage the adoption of more inclusive practices by fostering openness, sharing, and making a commitment to dismantling these obstacles. To make this happen, we must empower individuals, promote allyship, build grassroots communities, and offer mentorship opportunities. We can only create a pathway towards meaningful change by understanding the cultural factors that contribute to these barriers.

10. Conclusion

I hope that "future generations will look at the term "Open Science" as a tautology - a throwback from an era before science woke up. "Open science" will simply become known as science, and the closed, secretive practices that define our current culture will seem as primitive to them as alchemy is to us [27,28]".

About the author

Caleb Kibet is a bioinformatics researcher, a lecturer, an open science advocate, and a mentor. He has a Ph.D. in Bioinformatics from Rhodes University, South Africa. In addition to teaching bioinformatics at Pwani University, Dr. Kibet was a PostDoc at icipe, The International Centre of Insect Physiology and Ecology in Nairobi, and currently a data scientists at International Aids Vaccine Innitiative. As a

2019–20 Mozilla open science fellow, he developed a research data management framework for resource-constrained regions. He is also a member of the Dryad Scientific Advisory Board and a board member of the open Bioinformatics Foundation.

Dr. Kibet is passionate about open science and reproducible bioinformatics research. He is a founder of OpenScienceKE, an initiative that promotes open approaches to bioinformatics research in Kenya, and he is involved in bioinformatics capacity building through the Human Heredity and Health for Africa Bioinformatics Network and the Eastern African Network for Bioinformatics training.

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