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Mentored postdoctoral training in Zimbabwe: A report on a successful collaborative effort

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Abstract

Low-and-middle-income countries (LMICs) have high disease burdens, necessitating increased research. However, LMIC research output constitutes only 2% of global total. To increase output, researchers must be capacitated. The University of Zimbabwe (UZ) and the University at Buffalo (UB), developed and implemented the AIDS International Research Training Program (AITRP), in 2008, that focused on graduate scholars. The subsequent HIV Research Training Program (H RTP), begun in 2016, and piloted post-doctoral training

to enhance research productivity at UZ. This report discusses the collaboration. As of 2016, prospective candidates applied by submitting letters of intent, research proposals, curriculum vitae and biographical sketches. The scholars research training included hypothesis and project development, completion of grant applications, research project budgets, research presentations to diverse audiences and the application of advanced statistics to research data. The first cohort of five postdoctoral scholars were trained at UZ and UB, between 2016 and 2019. Through the formalized postdoctoral training approach, scholars identified areas of focus. In 2017, one of the scholars obtained a National Institutes of Health (NIH) Emerging Global Leader Award and is now a highly-rated researcher based in South Africa. A second scholar made NIH D43 and K43 grant applications, while the remaining three are academicians and early researchers at UZ. Although research output in Africa and many LMICs is low, it can be built through cooperation similar to the UZ-UB H RTP. This manuscript reports on an effort aimed at building individual and institutional research capacity in Zimbabwe. This can serve as a model for building other similar training programs.

Introduction

Africa accounts for 15-20% of the world's population and a disproportionately large share of disease burden (EDCTP-AREF, 2018). However academic research output from Africa accounts for less than 1% of the global output (Elsevier Connect, 2018). Owing to low research output, universities in Africa barely contribute solutions to their local problems, creating a knowledge gap whilst only a handful of them feature in the top 1000 university rankings (University World News, 2017, Times Higher Education Rankings, 2019). These statistics implore early researchers in African universities to study critical issues around local and global health, from an African perspective.¹ Formalized training with increased mentorship is expected to enhance research capacity and output as illustrated in Figure 1.

The Brain Drain

There are reports of brain drain of well-trained researchers from the African continent and many low-and-middle-income-countries (LMICs) to high-income-countries (HICs) in search of better opportunities.^{2,3} However, there has been recent impetus to "train global

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leaders to tackle the complex health problems in Africa and elsewhere" by funding agencies based in HICs such as: United States of America (Glass RI, 2017, NIH communication), Europe and the United Kingdom (Wellcome Trust, Africa and Asia programmes, 2019). This training of African and LMIC postdoctoral researchers in their countries aims to equip them to work on innovative research in their respective contexts. However, in light of the threat of brain drain, LMIC researchers require programs encouraging retention within their home countries.^{4,5} Additionally, more funding sources and philanthropic contributions together with the transfer of new technologies are necessary.

Research and Development Spending

The top nine countries by research and development spending are: United States of America, China, Japan, Germany, South Korea, India, France, United Kingdom, Russia and Brazil. The top two in Africa (Egypt and South Africa) rank 30th and 33th, respectively in the world by research and development spending (OECD, 2019). The South African and the Egyptian governments, dedicate approximately 0.8% of their GDP towards research and development.^{6,7} In order to encourage research, South African universities receive performance-based funds, rewarding the most research-productive universities.^{6,7} Yet, in absolute terms, LMIC and African scientific research is still mostly funded by international agencies and organizations.⁸ In order to develop their economies LMIC governments should mobilize more funding towards research and development (Acharya *et al.*, 2019).

Postdoctoral Training

Doctoral graduates justly pride themselves on their research expertise, but high impact research and grant funding acquisition requires additional skills. Most LMIC early career researchers are confronted with evolving research policies and suboptimal infrastructure capacity. This poses a challenge when competing for global funding.^{9,10} The challenge calls for an urgency in

creating collaborative scientific teams including senior academics, late career researchers and administrative leaders, willing to mentor early career academic researchers beyond the doctoral level.

Mentored Training

In order to improve research output and research grant access, universities in LMICs should leverage current academic collaborations and focus on enhancing research capacity and funding eligibility. According to the National Institute of Health (NIH), applications are evaluated for significance, experience of investigator(s), responsible conduct of research, innovation, approach, budget and justification, data sharing and resources and environment; these are scored individually and considered in an overall impact score (NIH, 2018). For training grants, reviewers also score recruitment and retention plans, applicant diversity, content and effectiveness of training in the responsible conduct of research (NIH, 2018). Finally, once success is achieved and the research momentum has begun, measures to sustain the academic research workforce must be realized and implemented. This is partly reflected in the current collaboration between University of Zimbabwe (UZ) and University at Buffalo (UB). To achieve sustainability, it is essential to augment advanced research education and create career pathways that support senior scientists who act as mentors in LMICs.

The Individual Development Plans

Career planning and formal mentoring is rare in many LMIC and African research settings. There has, however, been recent emphasis by the NIH on the value of career planning for basic science PhDs and the need for all NIH-sponsored fellows to develop Individual Development Plans (IDPs) (NIH, 2014). The purpose of the IDP is to “provide a planning process that identifies both professional development needs and career objectives”. Furthermore, IDPs serve as a communication tool between mentees and their mentors (Duke University Office of Postdoc Affairs Resources). Ideally, IDPs must include defined time and resources, comprise traceable tools to plan career pathways and measure fellow growth (The Ohio State University, Office of Postdoctoral Affairs).

Recent Calls for Mentorship Training and Institutional Support in LMICs

The Fogarty International Center (FIC) is the primary centre in the NIH dedicated to advancing global health research conducted by U.S. and international investigators and training the next generation of scientists to address global health needs (NIH, 2017). A call was recently made by Fogarty Scholars and Fellows program faculty and alumni, for expansion of mentorship training and institutional support in LMICs. The

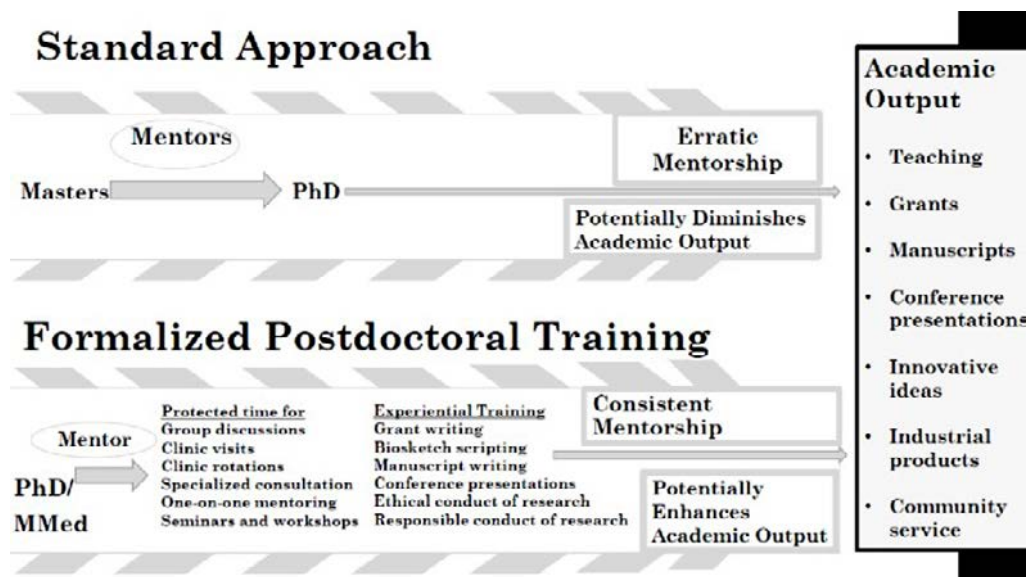


Figure 1. The benefits of the UZ-UB formalized postdoctoral training approach includes a focused mentoring of trainees using various methods ranging from one-on-one meetings, a group forum, and collaborative activities such as grant writing and manuscript writing. A structured training visit to UB creates protected time for research and for activities that generate new research skills and improve the fellow's research portfolio.

call encourages LMIC organizations to strengthen mentoring and institutionalize the practice (FIC, 2018). Hence, one of the FIC's latest areas of focus is to increase support for mentorship training in LMICs.

Funding and Training Strategies for Early Researchers from LMICs

Many LMICs have an inadequate number of academics with PhD qualifications. Mentoring training may help LMIC universities to develop research groups and centres of excellence to serve as training grounds for doctoral scholars. These research cores could be designed in a similar fashion to HIC cores. Senior academics, experienced researchers, postdoctoral and postgraduate scholars collaborate and contribute towards grant writing to reduce challenges of limited research funding.¹¹ In order to address funding constraints and many other challenges many global and local organizations have developed funding and training strategies for early researchers from LMICs, which could be frameworks for similar programs (Table 1).

The Multi-dimensional Systems Approach

Many national and international initiatives are based upon a premise that assumes that countries, particularly LMICs currently have weak research capacity.¹² However, there are suggestions to move away from a narrow definition, focusing on building a critical mass of trained researchers with the appropriate mix of skills. New emphasis should be placed towards multi-dimensional systems approach, which encompasses individual training, institutional development, national health research systems and supranational health research bodies.¹³

Models for Research Training in LMICs

According to literature, a postdoctoral program allows a graduate with a doctoral qualification to prepare for a more senior position. Therefore, regions that have success in research have made a deliberate effort to create the right research environment that involves continued mentoring throughout the academic's life. The UZ has leveraged on existing opportunities such as the NIH-FIC funded HIV Research Training Program, the Promote Excellence in Research and Faculty Enhanced Career

Training (PERFECT), the Welcome Trust-funded African Mental Health Research Initiative (AMARI) and Partnership in Education Training and Research Advancement (PETRA). These collaborations have been extended to prepare junior academics for local and global research funding acquisition and technology transfer.

The UZ-UB HIV Research Training Program postdoctoral fellowship

Below is a synopsis of activities embarked on in establishing the NIH Fogarty International Center UZ-UB HIV Research Training Program postdoctoral fellowship.

Program Setting

Zimbabwe is classified as a low- and middle- income country on the World Bank rankings. The premier Zimbabwean university, the University of Zimbabwe (UZ) is domiciled in the capital city, Harare. UZ comprises nine faculties and one college (the College of Health Sciences). The University at Buffalo, State University of New York, (UB) in the USA is the largest, most comprehensive institution in the 64-campus system of public institutions of higher education in New York. It is research-intensive public university, consisting of 13 schools and colleges. The UZ and the UB partnered to establish the AIRTP in 2009, followed by the H RTP in 2016. The collaborative effort is mainly supported by the NIH FIC, USA through highly competitive training grants and supplements. Faculty at both institutions contribute towards grant writing and mentored training to UZ MPhil, DPhil students and most recently postdoctoral scholars. The

postdoctoral scholars develop their research career during the program and continue in a collaborative, mentored environment after the training period.

Recruitment

Postdoctoral scholars with PhD or MMed qualifications from specified research areas, were recruited in a competitive process from University of Zimbabwe.

Creation of a Program Toolbox

A program toolbox was created, comprising training guidelines and outcome matrix for self-assessment by fellows. Key research skills to be acquired by the fellows include: knowledge of the responsible conduct of research, calculating sample size estimates and designing data analysis plans, setting up centres of excellence, training programs and research groups and understanding key aspects of multidisciplinary research teams, team dynamics and the process of scientific dissemination (Table 2).

The Postdoctoral Training Program

Successful applicants were required to produce a draft IDP. With guidance from mentors and administrative staff at UZ and UB, fellows were subsequently required to plan for short visits to Buffalo. The main focus and activities of the visit was driven by the Postdoctoral scholars' IDP (Figure 2). Fellows worked closely with experienced academics and researchers from global academic and research institutions, including UZ, UB and other collaborators (Figure 3).

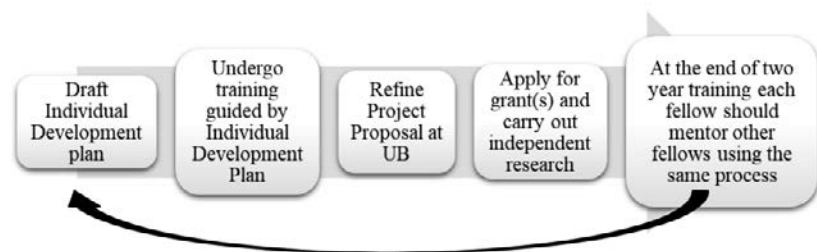


Figure 2. Flow chart of training program: Fellows are required to produce an individual development plan (IDP), with assistance of their mentors, in which their individual areas of focus for training are clearly specified. Mentees undergo training using one-one-one mentoring, collaborative assignments, work shadowing and experiential learning. Through this formalized training each mentee is expected to develop skills to be able to mentor others in future.

Table 1. Examples of Postdoctoral training programs in LMICs.

Target	Program Name	Funding source	Description	Duration
University of Zimbabwe (UZ) junior academics	UZ-University at Buffalo, State University of New York (UB) HIV Research Training Program	NIH Fogarty International Center	Training program involves continuous training at UZ and a short visit at the UB. The program also emphasizes infrastructure & technology transfer	24 months
Postdoctoral scholars from LMIC or the US	Global Health Program for Fellows and Scholars	NIH Fogarty International Center	Grant supports U.S. university consortia to provide collaborative, mentored global health research training opportunities in LMICs. Consortia of 6 U.S. universities: Harvard University; University of California, Berkeley; University of California, Global Health Institute; University of North Carolina, Chapel Hill; University of Washington and Vanderbilt University.	12 months
Post-doctoral trainees from Africa	African Postdoctoral Training Initiative (APTI)	African Academy of Sciences, NIH and Bill & Melinda Gates Foundation	Training is based at the intramural laboratories of NIH	36 months
Master's, PhD, Post-doctoral trainees	The Next Generation Scientist program: capacity-building for future scientific leaders in LMIC	University of Basel and Novartis, Switzerland	Recruited scientists and clinicians who wished to pursue scientific and leadership skills development to complement instruction at their home institution.	3 months attachment (2011-2017)
Citizen of developing country (other than South Africa)	TWAS-NRF Postdoctoral Fellowships	TWAS and South African government	Tenable at research institutions in South Africa, awarded to enable scientists to pursue postdoctoral research in the natural sciences	6-24 months
African researchers	AESA-RISE Postdoctoral Fellowship Program (African Academy of Sciences)	Carnegie Corporation of New York	Fellowship includes short research & mentorship visits at institutions in US and Europe	36 months
Brazilian Postdoc researchers	IASA-CAPES Post-doctoral fellowship	International Institute for Applied Systems Analysis	Program offers doctoral and postdoctoral opportunities for Brazilian nationals and permanent residents.	24 months
Sub-Saharan African Postdoc researchers	Postdoctoral Fellowships in Sub-Saharan Africa at DAAD supported Centres of Excellence	German government (Germany Academic Exchange Service-DAAD)	Sub-Saharan Africa postdoctoral researchers conduct co-operative research within the region, under the guidance of one of the host institutions	3-6 months
Women scientists based in Science and Technology lagging countries	Early Career Women Scientists (ECWS) Fellowships managed by OWSD	International Development Research Centre (IDRC), Canada.	To enable women fellows to maintain international standard of research as well as initiate collaborations and partnerships with industry and the private sector.	Up to 24 months
Postdoctoral fellows of any nationality working in South Africa	Claude Leon Fellowships	Claude Leon Foundation	To help build research capacity in South African universities and research institutions in Science, Engineering and Medical Sciences and increase the volume and quality of research output, develop and transfer technical skills	24 months
Postdoctoral fellows of any nationality working in South Africa	NRF Postdoctoral fellowships	South African NRF	Postdoctoral fellowships are open to all nationalities, are awarded on a competitive basis, considering the applicant's academic achievements and researcher potential and research output.	24 months
Postdoctoral fellows	IDeAL	Wellcome Trust-KEMRI	Provides support for postdoctoral training for African researchers in the early stages of their careers. Postdoctoral fellows may apply for independent funding, developing competitive grant proposal to progress towards becoming senior or principle research fellows.	12-24 months
Fellows from Makerere of Cambridge, University and University of Ghana	CAPREx Fellowships	Cambridge-Africa Partnership for Research Excellence	Partnership between University UK; Makerere University, Uganda; and the University of Ghana, Legon; aims to strengthen Africa's capacity for sustainable excellence in research	12 months

Duration

The postdoctoral fellowship is a 12- to 24-month program.

Main outcome measures

At the end of the training all fellows were to acquire skills and competencies listed in the toolbox in Table 2.

Recruitment Report

One scholar from the predecessor program of the HRTP, AITRP, was recruited for postdoctoral fellowship in 2016, and visited UB in 2018. The first HRTP postdoctoral fellow was recruited in 2017 and visited UB for a six-month exchange visit, the same year. In the period 2018 to 2019, three more HRTP fellows were recruited and travelled from Harare to Buffalo with intensive IDPs to guide their activities. The program is ongoing and senior academics and researchers will continue to mentor the postdoctoral fellows when they return back to their home country, with a focus on scientific leadership training, project management, grant writing, team management and technology transfer. The research focus and main activities that scholars participated in during the fellowship are shown in Table 3.

Outcomes

Five postdoctoral scholars have been trained at UZ and UB, between 2016 and 2019. Through the formalized postdoctoral training approach, scholars identified areas of focus, with assistance of their UZ and UB mentors. In 2017, one AITRP scholar obtained a National Institutes of Health (NIH) Emerging Global Leader K43 Award for a nanotechnology research project and is now a highly-rated researcher based in

South Africa. One HRTP scholar has submitted NIH K43 and D43 grant applications in behavioural health while the remaining three are academicians and early researchers, in different departments at UZ.

Conclusions

The advancement of global health research demands sustained career development opportunities for LMIC scientists that can only be attained via the implementation and dissemination of culturally compatible mentoring practices (FIC, 2019). Formal mentoring is not yet common practice in many of the LMIC institutions that conduct global health research. However, a growing number of LMIC scientists are interested in

mentorship, while funding agencies encourage mentored training (FIC, 2019). The UZ-UB HRTP postdoctoral program is a formalized training that is based on continued mentoring. The uniqueness of this program is its emphasis on an individual development plan and its integration with technology transfer. Continued one-on-one mentoring at UZ and sustained communication between mentees and UB mentors is set to expand grant writing expertise and bridge the technology gap.

Local funding initiatives for scientific work is minimal in Africa and in many LMICs.⁸ However, a few African countries, including South Africa and Egypt, have recorded some research success and academics from these countries receive grant funding from their governments.^{6,7} African

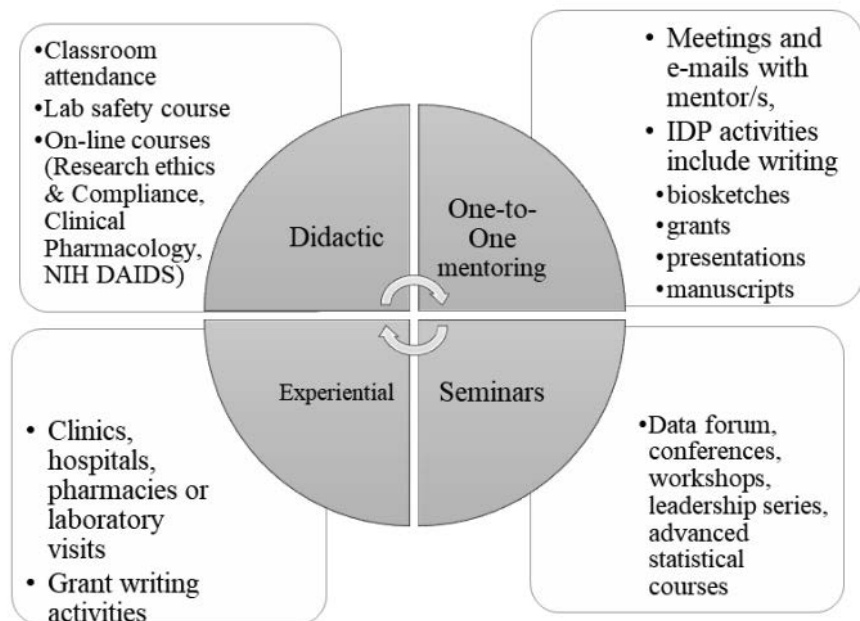


Figure 3. Format of training, Fellows are trained using various means ranging from didactic teaching, seminars, one-on-one mentoring and experiential learning.

Table 2. Toolbox research skills and competencies.

Key Toolbox Research Skills	Role in Training Independent Researcher
Develop a comprehensive knowledge of the responsible conduct of research.	Design and conduct research protocols of the highest quality and ethical standards.
Design a prospective protocol including sample size estimates and data analysis plans.	Design research protocols that have adequate statistical power to detect differences between groups and gain successful IRB or peer funding review.
Utilize the skills gained to set up Centres of Excellence, training programs and research groups	Employ postdoctoral skills in conducting research, identifying novel research areas, setting up Centres of Excellence, training programs and research groups.
Employ the principles of the development and validation of laboratory assays.	Demonstrate ability to discern accurate and reproducible assay data and be able to interpret assay data
Demonstrate an understanding of key aspects of multidisciplinary research teams, team dynamics and the process of scientific dissemination.	Participate in activities in multidisciplinary research teams, and analyze and disseminate research findings through peer reviewed mechanisms.

Table 3. Case studies of the current crop of H RTP postdoctoral program fellows.

No.	Qualifications and Field	Research Focus	Main Activities
1	BPharm, MPharm, PhD: Pharmaceutical Sciences	Pharmaceutical sciences: Developing nanoparticles capable of stimulating the innate immune system to achieve <i>Mycobacterium tuberculosis</i> eradication	Conference presentations Experiential learning: UB one-one-one mentoring Grant applications: K43 Grant awarded: NIH Global Leader Award (K43)
2	MChB, MMed: Paediatrics	Drug-drug interactions and TDF/Renal failure in Paediatrics	Conference presentation: Presented TDF and Renal Function abstract at Zimbabwe Medical Association Annual Conference 2017, Poster Presentation Southern African HIV Clinician Society SA October 2018. One manuscript under review Courses attended: Clinical and Translational Research Core Competencies on Good Clinical Practice: ICH, GCP, ISO, Informed consent; Surviving research audit; What makes a clinical trial GCP compliant?; CITI Training: HSP and HIPAA, Biomedical Investigators; GCP, DAIDS: National Institute of Allergy and Infectious disease Division of AIDS, Tuberculosis infection control, Bioanalytical Method Validation Tutorial Experiential learning: Clinic rotations
3	MChB, MMed, PhD: Psychiatry	Mental health, alcohol use and stigma in HIV patients	Two Conference presentations One research manuscript and two review papers submitted Courses attended: Advanced Statistics, Advanced Leadership & Innovation Experiential learning: Clinic rotations Grant applications: D43, K43
4	BSc Hons, MSc, PhD: Clinical Biochemistry	Genomics and Bioinformatics	Three international and one national conference presentations: (University of Rochester, USA; University of Makerere, Uganda; University of Zululand, South Africa; African Institute of Biomedical Science and Technology, Zimbabwe) Two manuscripts under review Courses attended: Advanced Statistics, Advanced Leadership & Innovation, Pharmacogenomics, Principles of Clinical Pharmacology, Research Ethics & Compliance Training Experiential learning in laboratories: Pharmacology, Next Generation Sequencing (NGS), Pharmaceutical Sciences, Immunogenomics Carrying out a pharmacogenomic project on a Zimbabwe cohort of HIV-infected patients
5	MChB, MMed/ Radiotherapy and Oncology	HIV-Oncology Therapeutics	Two conference presentations Currently at UB for advanced oncology training

countries and many LMIC should encourage local funding towards research as a way to reduce dependency on foreign donor funding and increase research output. Additionally, junior researchers, who are trained, may not be retained because of poor prospects in terms of career growth.^{2,3} Postdoctoral training programs in LMIC and Africa could benefit greatly from resource and budget-sharing between training partners.

Finally, the major challenge in reducing the growing gap between the scientific potential of HIC and LMIC lies in effective institutional capacity building. According to a WHO report (2001c): “Isolated programs to create researchers without research system development will be ineffective since the researchers produced would not have

stable career and job opportunities.” Key features of good institutional capacity include having a critical mass of research and support staff, strong leadership, stable and sustainable funding and adequate physical infrastructure. Hence the training of postdoctoral scholars should be more comprehensive to include strengthening of organizational structures and improving the national and international research environments. Constant mentoring and collaboration are proven methods for accessing grants and it is expected that early researchers and academics at UZ will continue to benefit from formalized postdoctoral training in the UZ-UB H RTP.

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