Chapter 7
Promises and Perils of Open Source Technologies for Development: Can the "Subaltern" Research and Innovate?

Sachiko Hirosue, Denisa Kera and Hermes Huang

Abstract The paper summarizes the current state of the "Openness Paradigm" for development, with a focus on open source hardware and the related issues of open science, open data, and open access. It focuses on how such efforts support more equal collaborations between North and South on open science and citizen projects. It also discusses these efforts as an example of an inclusive Research and Development (R&D) agenda different from the traditional practice of technology transfer, which enforces the hierarchical notion of "development." We apply the present postcolonial studies discourse along with contemporary discussions in the west on public participation in science, as a framework to discuss Technology for Development (Tech4Dev). Thus, bringing attention to nontraditional formats and institutions, and new institution–community relations, as examples of a more democratic and inclusive Tech4Dev agenda.

7.1 Introduction

The attempts to discuss science and technology in the Global South must address the "subaltern" issue before discussing the promises and perils of the Open Source Technologies. The "subaltern" issue refers to the famous essay by Spivak (1988), which posed the difficult question of how to resist epistemic violence behind

S. Hirosue
Institute of Bioengineering, School of Life Sciences, Ecole Polytechnique Fédérale de Lausanne, Lausanne, Switzerland
e-mail: sachiko.hirosue@epfl.ch

D. Kera (✉)
Department of Communications and New Media, National University of Singapore, Singapore, Singapore
e-mail: denisa@nus.edu.sg

H. Huang
International Development Studies Program, Faculty of Political Science, Chulalongkorn University, Bangkok, Thailand

S. Hostettler et al. (eds.), *Technologies for Development*,
DOI 10.1007/978-3-319-16247-8_7

various attempts to give voice and agency to the "Other" (developing, Third World countries). The "Other" is not simply a fellow human or a group with whom we happen to live on the same planet waiting for an opportunity for mutual recognition and appreciation. To question this contemporary fantasy of the "generous" acts of recognizing and admiring the "Other" in the unproblematic plurality of the worlds, Spivak uses the Gramscian term of the "subaltern" (Gramsci 1971). The "subaltern" as a group bears witness that there are no neutral "Others," but a shared history of various social, political, economic, cultural, and other forms of exclusions and oppressions, which need to be addressed before we engage in any emancipation campaign.

The epistemic violence behind the concepts of knowledge, reason, and we shall add development, lies in the fact that these categories are imposed as universal and somehow neutral, with good intentions, while forgetting their geographical, cultural, but also historical and economic contexts and agendas. How to control and even resist the Universalist aspirations behind the attempts to enable science and technology as tools and even goals of development in the Global South? How to resist the reverse (we could even call it "orientalist" (Said 1978; Adas 1989) fantasy of some indigenous knowledge and grassroots innovation (Rata 2011; Singh et al. 2012) as something, which needs recognition and care for its exoticism? Just as there are no neutral "Others" outside of common history, there are also no human activities, practices, or forms of knowledge, which are unproblematic in its past and future agendas and aspirations. In this sense, the challenge is whether the "subaltern" can research and innovate without adopting these agendas of the current power structures with their uncanny colonial roots.[1]

The discussions about the possibilities of research and technology innovation in the Global South often reproduce various forms of epistemic violence (Forero-Pineda 2006; Guédon 2008; Holmgren and Schnitzer 2004). We often summarize them as variants of the discussions on the deficit model (Freeman and Perez 1988; Byerlee and Fischer 2002; Forero-Pineda 2006). The current forms of epistemic violence in the discourses upon technologies for development all start with the following juxtaposition. Research and Development (R&D) and innovation are buzzwords, which frame the discourses of development in the west, while the Global South is often perceived as place of deficit, lack and digital amongst other divides (Warschauer 2003; Strover 2003; Young 2001), which simply await to be bridged. The epistemic violence behind this framework derives from defining technologies and science as something that is always transferred and applied in the South by the help of various donors, corporate responsibility programs or other innovators from the west.[2] In the best-case

[1]This pattern unfortunately is hard to expel, and can be seen reproduced across class, race, within a country.

[2]This transfer takes the form of collaborations, educational and empowerment programs, and material donations, but also conveniently as a new market for the technological innovations and solutions made by the Global North for the South.

scenario, the originators of R&D collaborate and work with the local communities to interpret their "local needs."[3]

It was exactly these forms of epistemic violence and vicious circles, which we decided to question in our panel "*The Openness Paradigm: How Synergies Between Open Access, Open Data, Open Science, Open Source Hardware, Open Drug Discovery Approaches Support Development*?" for the 2014 EPFL-UNESCO Conference on Technologies for Development (2014 Tech4Dev). We connected the discussions about the science in the Global South with the "Openness Paradigm," which allowed us to ask how science should be practiced in any community in a more critical and inclusive way. We looked into the synergies between various movements supporting open access, open data, open science, and open source hardware, to show how these emergent practices driven by the "Openness Paradigm" can reframe our ideas of development and science. We were interested in a type of agency, which can question the hegemonic views of science and technology development, and instead of lack, show examples of success and alternatives to how science is practiced in the west.

7.2 Subaltern Research and Development and Alternative Models

The speakers of the panel brought together material for a genuine reflection on what it means to know and innovate in a different context. The presentations by Gabriella Levine (United States) on water monitoring (Levine 2014) and Nur Akbar Arofatullah (Indonesia) on open hardware laboratory equipment (Arofatullah et al. 2014a) showed the promissory aspects of open source hardware for open science efforts. Open source hardware is defined as "hardware whose design is made publicly available so that anyone can study, modify, distribute, make, and sell the design or hardware based on that design" (OSHW_a, n.d.) and it offers an ideal tool for designing cheaper and customizable scientific equipment. In discussing her open hardware project, a biomimetic swimming robotic snake for education, research and environmental interventions, Levine pushed the issue of collaborative design iteration and community engagement. Her water robots, which can host sensors for monitoring water quality and other research, are all available through the sneel instructables site, which also shows the dissemination and impact of these tools with examples of replicated designs by people interested in citizen science. Levine discussed the hands-on workshops and hackathons related to Open Source Hardware Association (OSHW) projects as more decentralized and horizontal models of

[3]We do not intend to claim that Spivak's issue with the impossibility of the subaltern speech (and research) can be resolved. Despite this framework, we do believe there is value in the attempts to try and often fail in such efforts, for the sake of experiencing the paradoxes and opening the debate of what can be done further.

sharing knowledge and know-how and emphasized the empowering aspects of hands-on learning and technological innovations for people to "do their own science" (SciDev.Net 2014a). These concepts manifest in living practice was Arofatullah's presentation on open source laboratory equipment in Yogyakarta. Echoed in his statement, "*If you cannot buy one, let us try to build one, and learn valuable new skills in the process*." (SciDev.Net 2014b), the locally developed Do-It-Yourself (DIY) and Do-It-With-Others (DIWO) open source lab equipment fills the lack of resources in the university laboratories in Yogyakarta pointed out by Irfan Dwidya Prijambada's (Indonesia) presentation (Arofatullah et al. 2014b). With these self-made equipment, one can set up a full microbiology laboratory, with sterile hoods, shakers, PCR[4] and electrophoresis setups for molecular biology, to digital microscopes. Arofatullah is also active as one of the transdisicplinary practitioners in Lifepatch, citizen initiative in art, science and technology, where face-to-face hands-on workshops, both a learning and a teaching opportunity beyond the university, play an important role in building on the knowledge documented online. The alternative formats of learning and sharing (hackathons, barcamps, workshops, dissemination portals) feed knowledge and know-how, which have spread beyond the directional North–South axis, across cities and countries in the Global South, where the discussion of North–South becomes irrelevant.

The presentations by Nanjira Sambuli (Kenya), and Scott Edmunds (United Kingdom, China) explained the role of open data with special focus on better governance and genomics research. While the presentations on Indonesia and OSHW showed the value of community in open science projects, the example of open data in Kenya showed how scientific and technological progress are often part of democratization process. Kenya in this sense is a pioneer in supporting political transformation and personal empowerment through democratic and transparent forms of crowdsourcing data. The case study of the 2013 elections in Kenya presented by Sambuli compared active versus passive crowdsourcing suggesting a viable role for each type of participation (Sambuli et al. 2014). By actively recruiting participants through an open call, one gained less noisy actionable data, while passively "listening" to social media feeds gave the pulse of local events. This has also very important implications on engagement of citizens, the design of Open Science projects, and any project using the open data approach. Edmunds presented several examples (BBSRC media, n.d.; O'Brien 2012; MacLean et al. 2013; Li et al. 2014), in which China had a major impact as a pioneer in genomic research with their open data publishing efforts (Beijing Genomic Institute and Gigascience, respectively). The unprecedented efforts around the 2011 *Escherichia coli* 0104:H4 outbreak in Germany starkly highlights what timely outcomes can be achieved with Open Data and crowdsourcing genomic research supported by such an unlikely leader for massive scientific efforts from Shenzhen, China. Edmunds discussed the importance of the release of the initial sequence to the public domain, which

[4]Polymerase chain reaction (PCR), especially the quantitative PCR, now on kick-starter, is useful for genetic engineering, diagnostics, DNA fingerprinting, etc.

mobilized professional and citizen scientists to collaborate successfully to identify the strain, develop diagnostics and treatment (Edmunds et al. 2014). The standard politics and economic pressures of journals and patents would have altered the timeline and outcome. Here we see again, the Global South as a pioneer and model for scientific research efforts.

In this respect, the most striking was the presentation by Prijambada on the model of financing research and impact assessment implemented by the University of Gadjah Mada (UGM, Yogyakarta, Indonesia). UGM and other universities in Indonesia have an "Office of Research and Community Development" whose role is to organize groups of students and researchers across various often isolated communities on the islands in Indonesia and to help with various development tasks related to science and technology. The impact of university research is assessed by the impact on the communities. This is in sharp contrast to the prevalent models, which assess the university's impact by the research published in high impact journals with little if any concrete beneficial effects on communities given the resources expended (Alberts et al. 2014). The emphasis on applied research and spin-offs (McDevitt 2014), which binds research to deliver commercial success measured by short-term monetary returns on investment present a complete failure when facing immediate challenges of the communities shown in Prijambada's presentation. The presentation also showed the unlikely merging of the contemporary DIY and DIWO approaches to science through these established student community services in Indonesia. In the educational curriculum at UGM, required community service plays an important part in the social awareness of their graduates. As a highly regarded public university, they take the stewardship in weaving the complex networks of university, rural communities, and the nonprofit sector, without excluding new entrepreneurship opportunities (OSHW_a&b, n.d.).[5] This model of university–community relationships allows university research to respond to community needs.

7.3 Summary

The whole panel provocatively showed that the Global South is not only an alternative model for research and innovation efforts, but can actually inspire and lead the efforts in science and technology, especially in terms of its impact on communities. The Global South impress upon us as being a progressive site, where the future of science and community is reflected and questioned in a radical manner, which partially echo the postcolonial concepts of the "subaltern." The R&D in the Global South is bringing a form of subversive, almost subterranean concepts of science (and community) often outside the enlightenment and "modernization"

[5]OSHW states "Open source hardware gives people the freedom to control their technology while sharing knowledge and encouraging commerce through the open exchange of designs."

project (Banuri 1990), which share some of the values of DIY science as it is practiced in maker and hacker communities (Kera 2012, 2014). We are witnessing living, experimenting communities, which support the progressive and radical ideals of open science, open data, open technologies, and citizen science engagements with the enterprise of "Science." These approaches, upholding the "Openness Paradigm," are social as much as technical, which are objects and machines, as much as rules and licenses, hold the key to true development both in the South and North.

Still, more work needs to be done in terms of governance of these tools and emerging institutions. The direct connection of community building and prototype testing, the new global research networks around emergent and low-tech equipment, new practices of data publishing and sharing, all support the R&D innovation in developing countries. However, without testing, calibrating and making assessment, these tools will never resolve the actual problems or become scalable. All papers made calls for alternative, more holistic metrics for assessing research in the Global South and more South to South cooperation. An example of such an assessment was proposed by Sambuli et al. (2013) for crowdsourcing. The last paper presented, discusses the limits and problems related to these more democratized and publicly engaged forms of science and innovation. Kate Ettingers' presentation on "Open Issues and a Proposal for Open-source Data Monitoring to Assure Quality, Reliability, and Safety in Health Care Devices Targeting Low- and Middle-income Countries" (Ettinger 2015, Chap. 8) was a call for action for testing and calibrating open source tools to create some form of regulation, which will not betray the communities with a new hegemony. The paper made very clear that we need to collaborate and define new metrics for quality, reliability, and safety in Open Hardware equipment, especially for health care devices.

We concluded with our hope that future collaborations and funding schemes will address the need for a middle ground between science oligarchy, versus complete anarchy in open data and hardware. Our panel with the grouping of papers by scholars from various regions and disciplines demonstrates that the Global South can not only research and innovate, but also actually challenge the status quo of how science is done in the Global North. By carefully rephrasing Spivak's question, we posit that the "subaltern" can not only research and innovate, but they can dare to question what research and innovation means in the present economic and political climate (Brossard et al. 2005; Byerlee and Fischer 2002; Cohn 2008; Conrad and Hilchey 2011; Cooper 2012; Cooper et al. 2007; Dickinson et al. 2010). Rather than to navigate and negotiate current patent and publishing landscapes, which preserve the dominance of a few in scientific research and innovation, embracing the open source and open data technologies gives the opportunity to critically examine and reimagine the models of scientific research, economics and development. The science of tomorrow is science where precedents and transformations will come from unexpected places.

References

Adas, M. (1989). *Machines as the measure of man* (pp. 292–318). Ithaca: Cornell University Press.

Alberts, B., et al. (2014). Rescuing US biomedical research from its systemic flaws. In *Proceedings of the National Academy of Sciences*. http://www.pnas.org/content/111/16/5773. Accessed 29 Nov 2014.

Arofatullah N. A., et al. (2014a). Open hardware webcam microscope and its impact on citizen science Jogja River Project. In *Abstracts of 2014 EPFL-UNESCO Conference on Technologies for Development*. http://cooperation.epfl.ch/2014Tech4Dev. Accessed 29 Nov 2014.

Arofatullah, N. A., Widianto, D., & Prijambada, I. D. (2014b). Intersection of DIY (do it yourself) and DIWO (do it with others). Approaches in sharing microbiology know-how to benefit communities. In *Abstracts of 2014 EPFL-UNESCO Conference on Technologies for Development*. http://cooperation.epfl.ch/2014Tech4Dev. Accessed 29 Nov 2014.

Banuri, T. (1990). Modernization and its discontents: A cultural perspective on theories of development. In F. Apffel Marglin, & S. A. Marglin (Eds.), *Dominating knowledge: Development, culture, and resistance*. Oxford: Oxford University Press. http://www.oxfordscholarship.com/view/10.1093/acprof:oso/9780198286943.001.0001/acprof-9780198286943-chapter-3. Accessed 30 Nov 2014.

BBSRC Media (n.d.). *E. coli* 0104:H4 outbreak genome: fighting disease outbreaks with "the tweenome". https://www.youtube.com/watch?v=ttMnQIE-P-s&feature=youtu.be. Accessed 29 Nov 2014.

Brossard, D., Lewenstein, B., & Bonney, R. (2005). Scientific knowledge and attitude change: The impact of a citizen science project. *International Journal of Science Education, 27*(9), 1099–1121.

Byerlee, D., & Fischer, K. (2002). Accessing modern science: policy and institutional options for agricultural biotechnology in developing countries. *World Development, 30*(6), 931–948.

Cohn, J. P. (2008). Citizen science: Can volunteers do real research? *BioScience*, *58*(3), 192–197

Conrad, C. C., & Hilchey, K. G. (2011). A review of citizen science and community-based environmental monitoring: issues and opportunities. *Environmental Monitoring and Assessment, 176*(1–4), 273–291.

Cooper, C. B. (2012). Links and distinctions among citizenship, science, and citizen science. A response to the future of citizen science. *Democracy and Education*, *20*(2), Article 13.

Cooper, C.B., Dickinson, J., Phillips, T., & Bonney, R. (2007). Citizen science as a tool for conservation in residential ecosystems." *Ecology and Society*, *12*(2).

Dickinson, J. L., Zuckerberg, B., & Bonter, D. N. (2010). Citizen science as an ecological research tool: Challenges and benefits. *Annual Review of Ecology Evolution and Systematics, 41*, 49–72.

Edmunds, S., et al. (2014). GigaScience: Open publishing for the big data era. In *Abstracts of 2014 EPFL-UNESCO Conference on Technologies for Development*. http://cooperation.epfl.ch/2014Tech4Dev. Accessed 29 Nov 2014.

Ettinger, K. M. (2015). Open issues and a proposal for open-source data monitoring to assure quality, reliability, and safety in health care devices targeting low- and middle-income countries. In S. Hostettler, E. Hazboun & J.-C. Bolay (Eds.), *Technologies for development: What is essential*? Paris, Heidelberg, New York, Dordrecht, London: Springer.

Forero-Pineda, C. (2006). The impact of stronger intellectual property rights on science and technology in developing countries. *Research Policy, 35*(6), 808–824.

Freeman, C., & Perez, C. (1988). Structural crisis of adjustment, business cycles and investment behavior. In Dosi et al. (Eds.), *Technical change and economic theory* (pp. 38–66). London: Frances Pinter.

Gramsci, A. (1971). *Selections from the prison notebooks*. International Publishers Co., ISBN 0-7178-0397-X.

Guédon, J.-C. (2008). Open access and the divide between "mainstream" and "peripheral" science. http://eprints.rclis.org/10778/1/Brazil-final.pdf. Accessed 29 Nov 2014.

Holmgren, M., & Schnitzer, S. A. (2004). Science on the rise in developing countries. *PLoS Biology, 2*(1), e1. doi:10.1371/journal.pbio.0020001.

Kera, D. (2012). Hackerspaces and DIYbio in Asia: Connecting science and community with open data, kits and protocols. *Journal of Peer Production.* http://peerproduction.net/issues/issue-2/peer-reviewed-papers/diybio-in-asia/. Accessed 30 Nov 2014.

Kera, D. (2014). Innovation regimes based on collaborative and global tinkering: Synthetic biology and nanotechnology in the hackerspaces. *Technology in Society, 37*, 28–37. doi:10.1016/j.techsoc.2013.07.004.

Levine, G. (2014). Open source hardware biomimetic snake robot as a toolkit for monitoring and exploring marine environments. In *Abstracts of 2014 EPFL-UNESCO Conference on Technologies for Development*. http://cooperation.epfl.ch/2014Tech4Dev. Accessed 29 Nov 2014.

Li, Z., et al. (2014). The 3,000 rice genomes project. *GigaScience*, *3*(7). doi:10.1186/2047-217X-3-7.

MacLean, D. et al. (2013). Crowdsourcing genomic analyses of ash and ash dieback power to the people. *GigaScience, 2*(2). doi:10.1186/2047-217X-2-2.

McDevitt, V. L. (2014). More than money: the exponential impact of academic technology transfer. *Technology and Innovation*, *16*, 75–84. doi:10.3727/194982414X13971392823479

O'Brien, S. J. (2012). Genome empowerment for the Puerto Rican parrot—Amazona vittata. *GigaScience*, *1*(13). doi:10.1186/2047-217X-1-13.

OSHW_a (n.d.). Definition (English). http://www.oshwa.org/definition/. Accessed 29 Nov 2014.

OSHW_b (n.d.). Bio-fertilizers deriving from UGM research. http://www.gamaagri.com/. Accessed 29 Nov 2014.

Rata, E. (2011). A Critical Inquiry into indigenous knowledge claims. Presentation to the Department of Education, University of Cambridge. https://www.educ.cam.ac.uk/research/academicgroups/equality/Rata2-4.pdf. Accessed 29 Nov 2014.

Said, E. (1978). *Orientalism* (pp. 1–28). London: Routledge and Kegan Paul Ltd.

Sambuli, N., et al. (2013). Viability, verification, validity: 3Vs of crowdsourcing. iHub Research. http://www.ihub.co.ke/ihubresearch/jb_VsReportpdf2013-8-29-07-38-56.pdf. Accessed 29 Nov 2014.

Sambuli, N., et al. (2014). Crowdsourcing citizen-generated data for open science: A case study from the 2013 Kenya general elections. In *Abstracts of 2014 EPFL-UNESCO Conference on Technologies for Development*. http://cooperation.epfl.ch/2014Tech4Dev. Accessed 29 Nov 2014.

SciDev.Net (2014a). Are robotic snakes "essential" for development? http://www.scidev.net/global/technology/scidev-net-at-large/are-robotic-snakes-essential-for-development.html. Accessed 29 Nov 2014.

SciDev.Net (2014b). Hackers aim to reboot development with DIY mentality. http://www.scidev.net/global/innovation/news/hackers-aim-to-reboot-development-with-diy-mentality.html. Accessed 29 Nov 2014.

Singh, R., Gupta, V., & Mondal, A. (2012). Jugaad—from "making do" and "quick fix" to an innovative, sustainable and low-cost survival strategy at the bottom of the pyramid. *International Journal of Rural Management, 8*(1–2), 87–105. doi:10.1177/0973005212461995.

Spivak, G. C. (1988). Can the subaltern speak? In C. Nelson & L. Grossberg (Eds.), *Marxism and the interpretation of culture* (pp. 271–313). Urbana: University of Illinois Press.

Strover, S. (2003). Remapping the digital divide. *The Information Society: An International Journal, 19*(4), 275–277.

Warschauer, M. (2003). *Technology and social inclusion: Rethinking the digital divide*. Cambridge, MA: MIT Press.

Young, J. R. (2001). Does 'digital divide' rhetoric do more harm than good? Chronicle of Higher Education. http://chronicle.com/article/Does-Digital-Divide-/3058. Accessed 29 Nov 2014.