

Towards a More Gender-inclusive Open Source Community

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Authors and Editors



[The Digital Impact Alliance \(DIAL\)](#) aims to realize a more inclusive digital society in emerging markets, in which all women, men and children benefit from life-enhancing, mobile-based digital services. A partnership among USAID, the Bill & Melinda Gates Foundation, the Swedish government and the United Nations Foundation, DIAL's efforts help accelerate the collective efforts of government, industry and development organizations to realize this vision.

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[The Institute of Development Studies \(IDS\)](#) at the University of Sussex is a global research and learning organisation for equitable and sustainable change with the goal to accelerate sustainability and build more inclusive and secure societies through delivering and mobilising high quality research and knowledge that informs policy and practice, and through its world-recognised postgraduate degrees, PhD research and professional development services.

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Foreword

We hope you enjoy reading this report “Towards a More Gender-inclusive Open Source Community”, published by our team at the Digital Impact Alliance (DIAL) at the United Nations Foundation.

At DIAL, we’re the current stewards of the Principles for Digital Development, which help people deploying technology for international development to do so ethically and sustainably. One of those principles which we obviously believe strongly in, is “Use Open Standards, Open Data, Open Source, and Open Innovation”. For over two decades, the methods of the free and open source software movement have given us a technological “gift” that empowers quite literally anyone on the planet to become collective owners of impactful technology -- with the freedom to study, change, and share solutions that they can use to build society.

But open source alone, while critical in its promise to communities of their freedom to control their technological destinies, is not a panacea. Some of the other Principles our industry has adopted for example, “Design With the User”, “Build for Sustainability”, and “Be Collaborative”, call us to open wide the doors to our work, to gain the insight and knowledge of people of all experiences, backgrounds, and perspectives. Building inclusive technology projects and communities is a critical practice to achieve this diversity that is so critical to the long-term success of our work.

Unfortunately, over the past several decades, we’ve seen the technology industry as a whole -- including even open source, with its collaborative reputation -- evolve into a place that is not always welcoming to underrepresented groups.

This research report is the culmination of a thorough review of the literature, hundreds of hours in dialogue with leaders of, active participants in, and people who have turned away from open source communities, particularly focused at the “triple nexus” of international development, humanitarian assistance, and peace-making technology.

As people positioned to affect change in these communities, whether you are donor, a project maintainer, a contributor, or simply a supporter, you have the power to join us in evolving this space into a series of communities around the world that build bridges, embrace common bonds, and collaborate to work with people to design and build technology that helps them build better lives for themselves and for their families.

On behalf of all of our team at the Digital Impact Alliance, we hope you find this research insightful and share it with others.

*Kate Wilson
CEO, Digital Impact Alliance*



Executive summary

Creating an inclusive and enabling environment for gender diversity within open source¹ communities, particularly those working towards humanitarian and development outcomes, can contribute to two key outcomes. First, gender equality is a key tenet of Sustainable Development Goal 5, committing countries to work towards equal opportunities and empowerment for all women and girls.² Second, gender diversity can contribute to the development of open source technologies that better serve, and more closely meet the needs of, the communities for which they are designed.³ Yet the gender imbalance in open source remains profound.⁴

DIAL conducted this research to explore the experiences of women working in open source communities that create software for the humanitarian and international development sectors. It wanted to better understand why women are underrepresented and do not always feel welcome or supported in these communities. The findings of this research point to ways that different stakeholders – organizations supporting women in coding as well as open source communities, employers, conference organizers, governments and funders – can work together to build more vibrant and inclusive open source communities. Ideally, these communities would reflect the needs of women; provide them with the support they need to be successful; and ultimately, enable them to contribute to the development of more effective, equitable, and inclusive open source products.

This paper uses the framework presented in Bill and Melinda Gates Foundation's paper, "Conceptual Model of Women and Girl's Empowerment,"⁵ which details three types of transformational shifts that need to occur for meaningful change to take place. These include:

Types of Transformational Shifts

- Resources: what women need to participate equally in open source communities
- Institutional structures: the social arrangements and values that influence what women can achieve
- Agency: what women are able to do in terms of decision making, leadership and collective action

In terms of resources, women face many barriers in productively engaging in open source communities, such as navigating the cross-cultural intricacies of online communication, having enough time to contribute effectively, finding safe spaces to learn, and accessing support networks. The institutional structures that impact women working in open source communities include the established ways of thinking and acting that are perpetuated by family, schools, and employers, such as expectations around motherhood, barriers to accessing education, meritocracy and hiring procedures, and codes of conduct within open source communities. With regards to agency, there are challenges for women in navigating gender norms and expectations, working in unwelcome or hostile environments, and deeply rooted discrimination.

Ultimately, this research underscores the need for increasing the number of women in open source communities, and illustrates a series of recommendations, alongside examples of programs that provide the mentorship, training, and support required to do so.

¹ "Open source software refers to software that can be freely used and modified which is developed collaboratively over the Internet by teams of globally distributed and predominantly volunteer programmers. The open source movement is a continuation of a long tradition of sharing and cooperation that dates back to the early days of the Internet. OSS is protected under copyright licenses aiming to ensure the availability and free (re)distribution of the source code, the set of instructions written by developers that make up a program." Berdou, E. (2008). Open Source. In W. Donsbach (Ed.) International Encyclopedia of Communication. London: Wiley-Blackwell, doi:10.1002/9781405186407.wbieco011

² <https://sustainabledevelopment.un.org/sdg5>

³ Barker, L.; Mancha, C. and Ashcraft, C. (2014) What is the impact of gender diversity on technology business performance, National Center for Women and Information Technology. Available at: <https://www.ncwit.org/resources/what-impact-gender-diversity-technology-business-performance-research-summary>

⁴ A survey of contributors carried out in 2017 showed that only 3% were women. See: Zlonick, F. (2017). GitHub Open Source Survey 2017. Available at: <http://opensourcesurvey.org/2017/>

⁵ Eerdewijk, A.H.J.M. van; Wong, F.; Vaast, C.; Newton, J.; Tyszler, M. and Pennington, A. (2017) White paper: A conceptual model on women and girls' empowerment, Amsterdam: Royal Tropical Institute (KIT). Available at: https://www.kit.nl/wp-content/uploads/2018/10/BMGF_KIT_WhitePaper_web-1.pdf

2. Recommendations for Action

2.1 Organisations supporting women in coding

- Build women's agency by building structures of support, inspiration and encouragement such as mentoring, online forums, meet-ups, and vocational training that make women feel more able to pursue their interests in open source work.
- Work with schools, families and employers to change gendered expectations and prejudices about what constitutes women's and men's work.
- Secure and support internships and paid employment for women in open source projects and work with local media to raise the profile of women trailblazers.

2.2 Open Source Communities

- Build online peer-support networks for women in open source and moderate online forums to raise awareness among men and women about the benefits of diversity and inclusion in software development.
- Organise proactive measures to attract diverse talent to the community and to make them feel welcome and supported.
- Carry out research to understand what aspects of your community might be alien and uncomfortable for women or people from other ethnic or linguistic groups.
- Secure buy-in among community members for a code of conduct for online speech and behaviour and activities to make new hires feel welcomed and appreciated.
- Agree on escalating sanctions for anyone who abuses another community member.
- End all abuse and gender-based discrimination in your community through GBV or anti-harassment training and awareness raising.

2.3 Open Source Employers

- Build welcoming workplaces in which women are effectively supported and rewarded with equal recognition, pay and seniority.
- Involve all staff in awareness-raising about the value of diversity in teams and how to build a safe and respectful workplace.
- Involve staff in identifying opportunities for achieving those goals and codify staff suggestions into a code of conduct with sanctions.

- Track and make public the organisation's progress against diversity targets and achieving gender equity in engineering and senior roles.
- Embrace place of work and working hour flexibility in recognition of employees' diverse responsibilities.
- Valorise quality of work output in place of all-night working sessions. Achieve gender pay and representation parity in all senior levels of management and board.

2.4 Open Source Conferences

- Change men's values and behaviour. Equity can never be achieved without changing men's behaviour. The paucity of work in this space represents a massive missed opportunity. Open Source conferences are an ideal place to raise men's level of consciousness about the consequences of discrimination and to engage them in identifying and championing initiatives to change the situation.
- Conferences should provide women-only sessions as well as spaces for women and men to discuss together the consequences of discrimination and abuse; the benefits of inclusion and diversity; and how to work together to achieve it.
- Conference organisers can also help to ensure diversity of conference speakers and panels to provide role models for women and other under-represented groups.

2.5 Government and Funders

- Require diversity audits from companies bidding for tenders or funding and make annual progress against audit indicators a condition of future work.
- Require the same process and progress from your own internal departments. Use your convening power and financial leverage to bring together existing but disparate initiatives to learn from each other and to establish global networks that are able to drive an agenda for change at the highest levels.
- Piggyback on the many existing open source and women in tech conferences rather than reinventing the wheel.
- Provide bursaries to enable women and other under-represented groups to attend and build their social capital and agency.
- Sponsor sessions at existing open source conferences to influence the diversity of speakers, panels and topics.
- Sponsor women-only sessions as well as mixed women and men sessions to raise awareness of diversity issues within these large male-dominated gatherings as well as critical consciousness about the root-causes and possible solutions.

3. Introduction

DIAL's work focuses on unlocking markets and accelerating the rate at which digital development services can reach global scale. Our vision is a world in which the underserved benefit from digital technology.

The potential value of open source for development outcomes is reflected in the [Principles for Digital Development](#), "Use Open Standards, Open Data, Open Source, and Open Innovation," which encourages organisations to developing new software code as open source. As a product it is cost-effective and sustainable; if someone has the necessary expertise they can adopt it, translate and adapt it to their own needs without needing to pay for expensive licences. Their adaptations, in the form of a new side project, or as additions to the existing code base can also be of benefit to others, saving them time and money. This potential is reflected in the mission of the DIAL Open Source Center:

"Convene a vibrant and inclusive community for builders of free and open source software, promoting knowledge sharing, collaboration and co-investment in technology and human capacity to support positive social change in communities around the world."

The lack of women in the open source software sector is an important missed opportunity. The absence of a diverse range of voices in helping define what problems digital services should address and how undermines the efficacy of services and limits the possibilities for impactful innovation. DIAL's goal of building an inclusive digital society will not be realised without the contribution of women.

Collaboration among strangers is one of open source's most remarkable benefits, so it's vital to build communities where everyone feels welcome to participate. Many open source communities already provide a friendly and

supportive environment for women and new contributors. For example, a South African contributor to a large donor-supported open source software project noted the importance of being her authentic self in these spaces:

"... being welcomed in a space goes hand in hand with me feeling as if I can bring my whole self to this space. I don't have to "context switch", to become an open source version of myself to be not just welcomed but appreciated and feel like I'm needed in that space."

Unfortunately, open source communities do not always live up to this ideal. GitHub's 2017 survey⁶ found that in open source communities, women are more likely than men to encounter language or content that makes them feel unwelcome.

Open source projects are built around an architecture of participation that invites and supports different perspectives. This means that, in principle, they can offer more opportunities for a whole range of understandings to be incorporated into their design, including gender-specific issues. As a space that is open to all capable contributors, open source communities can also offer a learning platform for women volunteer developers to extend and refine their skills and gain confidence in their abilities. This could make a positive impact on their professional and personal lives. Research shows, however, that bias permeates open source communities. For example, a study on GitHub reviewed "pull requests," a process that occurs when someone identifies a way to improve a given project's code, and lead programmers approve or deny the submission. Results showed that programmers accept women's contributions more often than men's – but only when their gender is not identifiable.⁷ This suggests that although women on GitHub may be more competent overall, implicit bias against them still exists.

This issue is important not just because we want the open source communities to build better

⁶ Zlonick, F. (2017). GitHub Open Source Survey 2017. Available at: <http://opensourcesurvey.org/2017/>

⁷ Terrell, J., Kofink, A., Middleton, J., Rainear, C., Murphy-Hill, E., Parnin, C., & Stallings, J. (2017). Gender differences and bias in open source: pull request acceptance of women versus men. PeerJ Computer Science, 3. Chicago. Available at: <https://peerj.com/articles/cs-111/>

software. In the words of Melinda Gates, when we don't intentionally put women and girls at the centre of global development, we have "lost opportunities to maximize our impact across all of the arenas in which we work." The Gates Foundation conceptual model of empowerment of women and girls, which we have adopted in this study, shows that to give women power, relations need to be transformed at the level of resources, institutions and agency.

Achieving gender-balance on open source teams can deliver benefits such as software that is non gender biased, uses both male and female pronouns, excludes images that objectify women, and encourages gender positive projects that promote social change, as well as being a valuable endeavour in and of itself. It is not just about the number of women on a team, however, but also about enhancing the critical consciousness of FLOSS developers, improving their understanding of gender equality, and impacting their intention to produce software products that can deliver a range of better development outcomes.

4. Our Research

Although there is a growing body of research on gender in open source, very few investigations seek to understand the opportunities and challenges that participation poses to women from different socio-cultural backgrounds. This research addresses this gap by considering the experiences and views of women contributors from India, Kenya, Zambia, and African Francophone countries in addition to Europe, the US, and the UK. We interviewed programmers but also contributors, who write documentation, create artwork, translate (localize) programs and content, and maintain websites.⁸

4.1 Questions

We set out to answer the following questions:

- How do women's career pathways in open source compare to those of men across different sociocultural contexts, especially when considering these contexts' gender norms?
- What type(s) of women's involvement in open source communities are likely to incorporate their voice and priorities and result in projects that are better informed by a gender perspective? Are there, for example, possibilities for contributions associated with program design?
- What kind(s) of arrangements, formal and informal structures of support, and changes in established norms and behaviours are needed to support the meaningful participation of women in open source projects in different socio-economic contexts?

4.2 Data Collection

We combined background research on gender in open source with interviews. The research covered both academic and policy literature, as well as online practitioners' reflections and testimonies. The main study involved 44 individual, semi-structured interviews with two groups.

The first group was comprised of key individuals representing organizations aiming to promote, or with a capacity to promote, women's engagement in open source. The organizations fell into three categories: those that directly employ programmers working on open source projects; those that focus on philanthropic endeavors such as the Mozilla and Praekelt foundations; and those that are intermediary, such as the tech innovation incubator, iHub. We sought to recruit interviewees who were catalysers, consumers or producers of open source software. Most performed more than one of these roles. Interviews with this group focused on the women's perceived understanding of the challenges and opportunities they face

⁸ This is important as several studies indicate that women undertake more frequently non-programming tasks than their male colleagues (see e.g. Robles, G., Reina Arjona, L., González-Barahona, J. M., & Dueñas Domínguez, S. (2016). Women in Free/Libre/Open Source Software: The Situation in the 2010s. In K. Crowston, L. Hammouda, B. Robles, G., J. Gamalielsson, & J. Lindman (Eds.), Open Source Systems: Integrating Communities. OSS 2016. IFIP Advances in Information and Communication Technology, vol 472, pp. 163-173).

when they become engaged in open source development and the benefits and drawbacks of existing solutions aimed at increasing gender diversity in this space.

The second group was comprised of 24 interviews with women, primarily from developing countries, who are involved in open source as coders or non-coders (e.g., documenters, translators, etc), and volunteers or paid contributors (e.g., people who participate in open source as part of their regular

job). These interviews sought to understand the nature of women’s open source experience and the influence (or lack thereof) of the gender norms of their culture in their career trajectory. We also sought to capture their suggestions on what is needed to increase both the breadth, in terms of pure numbers, of women, as well as the depth of their influence and perspectives in open source.

Nationality and gender break-down of all interviewees

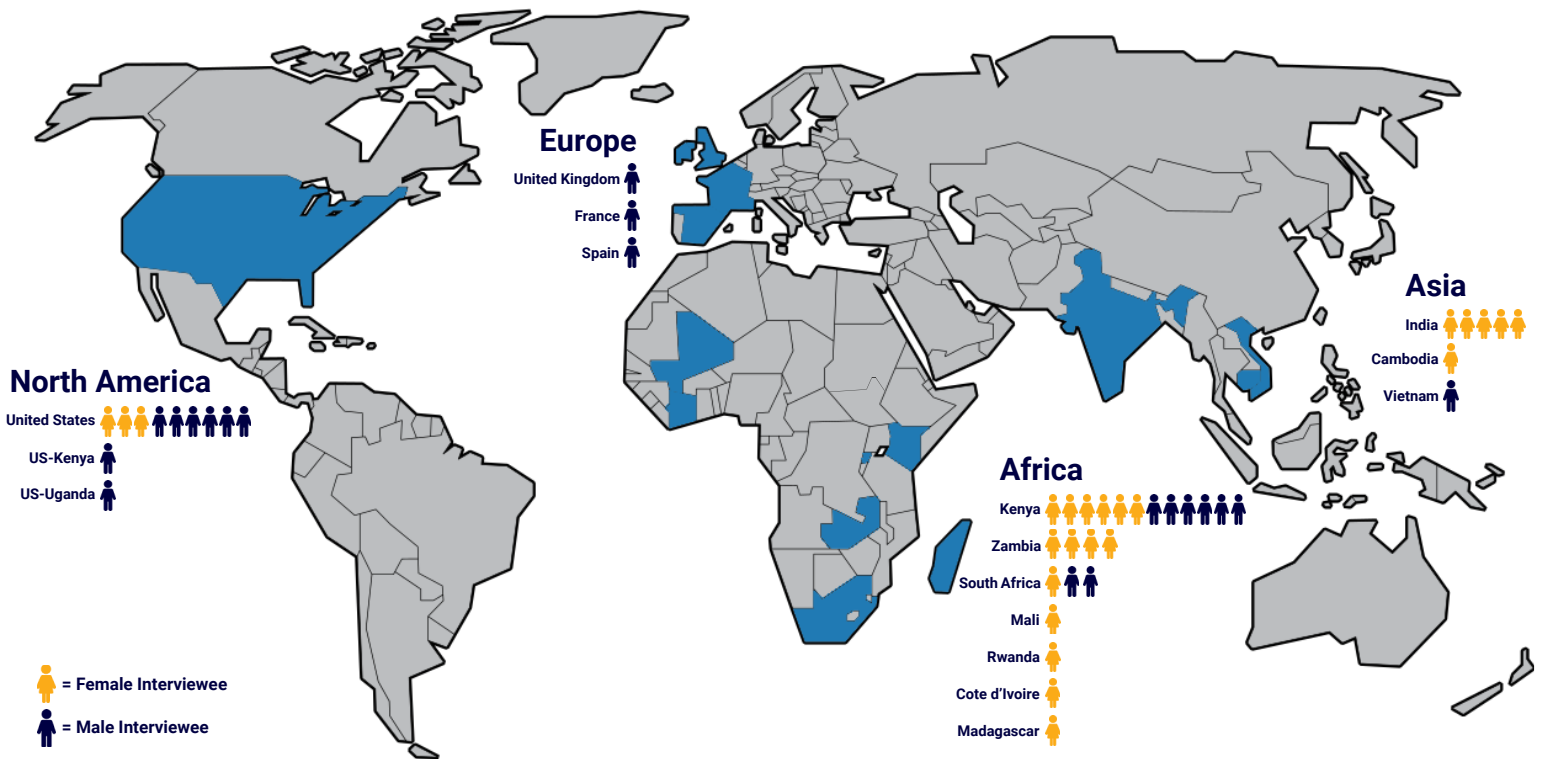


Table 1 below shows the open source communities and organizations in which our women contributors were active at the time of the interview.

Open Street Map (7)	Asikana Network (1)	Google Summer of Code (1)	INSTEDD (1)	Spiceworks (1)
Random Hacks of Kindness (1)	Eclipse (1)	Mojaloop (1)	OpenMRS (1)	Praekelt (1)
iHub (1)	IUSA (1)	Bahmni (1)	Sygmah (1)	M-Pesa (1)

The character of the projects we examined influenced the nature of our findings. We sought to include projects considered challenging in terms of promoting gender inclusion, as well as “women-friendly.”⁹ Many of the software projects in which our interviewees were engaged also differ from mainstream open source projects in that they usually benefit from, and sometimes are initiated through, funding from donors and other organizations.

We analysed interview transcripts thematically,¹⁰ focusing on identifying issues that we knew were important from our background research and also ones that emerged through the process of analysis. This method of analysis consisted of identifying themes and subthemes in the interviews related to a specific topic of interest for the research. For example, references to gender norms were grouped together and compared across interviews. A priori codes or themes were those that we had identified as important at the beginning of the research. Negative and positive aspects of participation were two such codes. Emerging themes included the idea of time as a precious resource and emotional labor as a part of participation.

From its inception to the final stages of analysis, our investigation benefited from relevant insights from studies on open source. We looked at those that explored open source more broadly as well as those that focused specifically on gender. Our background research examined the evolution of women’s participation in open source over the last fifteen years, patterns of exclusion and inclusion, values and norms underlying open source development, and systems of support.

4.3 Conceptual framework: what needs to happen for women to be empowered

The underrepresentation of women in open source communities presents a challenge to their commitment to social good. Digital technologies

and the codes and algorithms that underpin them inherently reflect the values and backgrounds of those who build them. Consequently, it is critical that the technology sector reflects diversity and inclusivity and ensures that women are welcomed and their perspectives incorporated and supported.

We explored the ideas presented in a paper by the Bill and Melinda Gates Foundation, entitled “Conceptual Model of Women and Girl’s empowerment,” (2017) to understand what needs to happen to achieve greater gender equality in open source. In this framework, shifts need to happen across three areas for meaningful change to take place.

1. **Resources:** These refer to the “tangible and intangible capital and sources of power that women and girls own or use individually and collectively in the exercise of agency.” We found that time, skills, safe spaces, networks and funding are key assets for supporting more meaningful engagement of women in open source.
2. **Institutional structures:** These are the social arrangements and values that influence what women can achieve. We found that family, school, meritocracy and codes of conduct are among the most important structures that can inhibit or sustain women’s participation in open source.
3. **Agency:** This captures what women can do in terms of decision making, leadership and collective action. With respect to women’s participation in open source, we found that agency is limited by traditional gender norms, the strain of having to operate in a hostile environment, and an underdeveloped critical consciousness among community participants, for example the ability of women and men to grasp and address the root causes of injustice.

⁹ These are projects that actively facilitate the involvement of women by upholding, for example, high standards of behaviour and valuing equally different forms of contribution (see, e.g. Moon, E. (2013). Gendered Patterns of Politeness in Free/Libre Open Source Software Development. Proceedings from 2013 46th Hawaii International Conference on System Sciences.)

¹⁰ Guest, G., MacQueen, K. M., & Emily, N. E. (2011). Applied Thematic Analysis. London: Sage.



5. Resources: what women need to participate equally in open source

Women face additional challenges related to traditional gender roles, particularly in resource-poor environments. In the Gates Foundation's framework, resources are what enable people to feel they can pursue their goals. These resources are not available to many women, who face barriers in productively engaging in open source communities, such as navigating the cross-cultural intricacies of online communication, having enough time to contribute effectively, finding safe spaces to learn and accessing networks of support.

5.1 Skills: beyond programming proficiency

Learning and honing new programming skills is a key motivator for people to contribute to open source projects. To take advantage of these opportunities, you need to be able to learn and problem-solve independently; unfortunately, these are skills that many public-school systems, especially in sub-Saharan Africa, do not cultivate.

Twenty of our women contributors agreed that soft skills, such as critical thinking, confidence, resilience and self-learning are equally, if not more, important than technical proficiency for successful participation in open source communities. When talking about confidence issues young female trainees in Kenya face, a senior female developer, reflected on the topic as follows:

"it's never a skills problem. When women with poorer backgrounds progress through training programs designed to help them, they can get stuck at junior level positions, despite being qualified to apply for more senior roles. This is because they do not believe they have the necessary skills to succeed."

In open source development, a high level of technical expertise is often expected, even from new contributors. Some interviewees feel like others were belittling them for asking basic

questions. One interviewee from India had studied computer science but never contributed to open source projects as she felt unsure of how to begin. Navigating male-dominated spaces such as hackathons, especially in the Global South, can be particularly challenging for women from lower socio-economic backgrounds who may not know how to “speak” or “behave” in these environments. Some women felt that they had to “leave their gender behind” to fit in.

5.2 The challenges of cross-cultural communication

Open source communities have often been characterised as communities of practice,¹¹ that is, social networks of practitioners that are bound together by common ideals and procedures seeking to promote sharing, learning and professional development. In the case of open source, this includes an emphasis on the free flow of information, versioning, and technical excellence. At the heart of the community of practice lies the assumption that communication among members is made easier by established norms and processes. It appears, however, that this shared framework of ideas and practices is not enough to transcend the difficulties of cross-cultural communication.

To better understand this, it’s important to point out first that software development communities are characterised by a combative style of communications, which can be off-putting.¹² Communication was a source of misunderstanding and tension for interviewees, especially among individuals from different cultures. The more direct style of communication adopted by many Americans and Europeans can come across as offensive in many other cultures. Learning to negotiate different styles of communication found among diverse cultures is an important skill that our interviewees felt they had to master to succeed. This was the case for one Indian woman, quoted below:

“...for me it’s more about race than gender. I find it easier to talk to an Indian man over say, an American woman.”

Finding ways to help women developers feel comfortable with and adapt to different communication styles is key¹³. One female open source community leader talked about how she made a point of welcoming all new members on board – male and female:

“Any time a new community member comes on board I start by introducing myself and establishing a personal connection. I’ll look at their pull requests to see if something needs feedback. I’ll give it to them right away but also make sure I’m appreciative.”

5.3 Time as luxury and privilege

Women’s participation in open source is profoundly impacted by constraints on and control of their time as well as the necessity to work much more than men.

Some interviewees commented directly on how open source community members thought about time. K., a leading OS developer for a mapping platform, pointed out that misconceptions around free time are still pervasive in the OS community despite mounting evidence to the contrary:

“There is an expectation that OS contributors are working in their free time. A lot of people, however, are doing it as work. It really is a myth that coders are working in their basement in their free time.”

For women from the Global South, the concept of time was often discussed in the context of traditional gender roles and responsibilities around housework and child rearing, which we will explore in more detail in a subsequent section. The following reflects a common sentiment we heard:

¹¹ For example, see O’Mahony, S., & Ferraro, F. (2007) The emergence of governance in an open source community. *Academy of Management Journal*, 50(5), 1079-1106 and von Krogh, G., Spaeth, S., & Lakhani, K. R. (2003) Community, Joining and Specialization in Open Source Software Innovation: a Case Study. *Research Policy*, 32(7), 1217-1241. Available at: https://www.jstor.org/stable/20159914?seq=1#metadata_info_tab_contents

¹² For example, see Ortu, M., Destefanis, G., Counsell, S., Swift, S., Tonelli, R., & Marchesi, M. (2017). How diverse is your team? Investigating gender and nationality diversity in GitHub teams. *Journal of Software Engineering Research and Development*, 5(1). <https://link.springer.com/article/10.1186/s40411-017-0044-y>

¹³ Ibid.

“What we need is a support network for new mums in technology. They’ve got two jobs and coming back after maternity leave is so hard.”

Mothers, especially those with newborns had to contend with misperceptions associated with their availability, productivity and ability to work overtime. Many women, such as this female programmer, reported having to put in extra effort to achieve the same level of recognition as their male counterparts:

“It makes me depressed that a man will do five hours work and get appreciation and I have to do ten hours to get the same appreciation. I have to work more hours than my male counterparts”

Contributors to open source communities often need to make an upfront investment of time and energy to develop their skills before they start earning money. Young female developers in the Global South often encountered significant opposition from their parents, who could not understand why their daughters would work such long hours without getting paid. Those with conservative families also found participation in evening meet-ups problematic since it involved spending unsupervised time with men. Interviewees’ parents were unfamiliar with these career requirements. This was particularly challenging for women from the South who were expected to start earning an income immediately upon graduating from university.

5.4 Money and volunteer labor: striking a balance

Access to basic resources such as functioning computers and connectivity, which people in more affluent countries take for granted, is a critical barrier to women’s participation in open source, as this founding member of a women’s coding project in Africa notes:

“Someone donated a bus and we used to load the computers on it and drive it to one of the slums so the girls could come in and learn. But it was really hectic because the roads are really bad and by the time we got there half the computers were not working.”

Women from Francophone countries faced financial challenges, which compounded the language barriers they encountered as participants in a predominantly English-speaking global community. One interviewee shared:

“I am the only woman in the community since it began. It is difficult to stay in it because you have no financial help and you must use your own money for training and making meals for the men. We conduct crowdfunding, but we still have to pay for room and internet connectivity.”

Voluntarism¹⁴ is unsustainable for many low-income women. Many interviewees were working two jobs: the first, their unpaid passion project; and the second, their paid employment to subsidize it. When asked to reflect on what solutions they regard as particularly promising for ramping up women’s engagement, interviewees often highlighted economic incentives from companies and funders that support open source development. For some interviewees, remuneration for their contribution to open source projects was a basic precondition for their long-term engagement and empowerment. An income gives women the freedom to leave hostile environments and a degree of power, since paid employees are more accountable to norms and standards of behavior than volunteers. An American OSS contributor reported:

“If you look at it from a social standpoint, a lot of the problems that arise within open source communities - especially as they become successful and scale – are related to balancing the needs of individuals and small developers who provide cutting edge, innovative thinking. But you also need these great companies to actually fund this stuff.”

¹⁴ “Volunteerism” and contributions to the “information commons”, of which open source software forms a part, is often created through the efforts of contributors working in their spare time, without remuneration. See, Berdou, E. (2017). Open Development in Poor Communities: Opportunities, Tensions and Dilemmas. Information Technologies & International Development, 13, 18-32. <http://itidjournal.org/index.php/itid/article/viewFile/1429/568>

Involvement of companies and organizations in open source also creates more accountability because they can make engaging women a condition of their agreement to fund projects. Many interviewees said that donors could use their “purchase power” to influence the ecosystem by adding indicators for gender equity into the Principles for Digital Development and ensuring that the open source projects they support include women.

5.5 Mapping diversity: knowing what numbers to fix

How do we know who participates in open source? Which communities and groups have the best and worst records for involving women and individuals from other under-represented groups? Which organizations have improved the most with respect to inclusion? If we are to change the gender imbalance in open source, we must know what numbers we are trying to fix. As one male leader in the open source development space stated, “Only things that are measured are counted.”

While some men demonstrated high levels of commitment to and awareness of gender equity, others struggled to understand what actions they might take to address these issues. For example, while tracking diversity was an organizational goal, one male leader bemoaned the fact that he simply did not have the time, resources or skills to measure gender balance in his project. He explained that participants did not have to declare their gender when creating accounts in large online communities, presenting a key barrier to tracking gender inclusion. If he were required to track this data to receive funding for a project, he thought he could do it if funders were to provide a “best practice guide”, that included instructions for the right tools to use and the right numbers to track. He was reluctant to take this on, however, without receiving any additional funds to support the change in process. His reluctance demonstrates the importance of

donors taking a leading role on this issue, both in issuing guidance and providing the necessary resources to track and improve diversity in projects they fund.

There is some progress in this area: most notably, Mozilla launched a survey to map Diversity & Inclusion in Open Source, which attracted 489 responses from open source contributors. Those surveyed indicated they were collecting data in different formats and in diverse ways. Mozilla’s Emma Irwin recommended the implementation of “metrics that matter with standards and best practices that we can share across the ecosystem.” These best practices included using a range of methodologies such as text-based chat to ensure “the introverts turned up” as well as people who spoke English as a second language. Mozilla also made a point of interviewing people in their local language when asking personal questions about diversity. It recognized that people would be more comfortable speaking in their native tongue when discussing sensitive topics and the company would be less likely to lose important feedback.¹⁵

5.6 Safe spaces and networks matter: building confidence through peer support and role models

There are many examples of women-only or women-friendly spaces and communities that play a vital role in attracting women to open source. Some of these include networks such as Kenya’s AkiraChix; geographically defined spaces such as Latin America’s OpenChicas, the association for female OpenStreetMap contributors; networks for women who “love working on Python” with different local chapters; women’s conferences like Adacamps; and women-only hackathons.

Interviewees considered these spaces and networks important for numerous reasons. First, they regarded them as safe incubators

¹⁵ Read more reflections on barriers faced by non-English speakers in open communities at; <http://tiptoes.ca/celebrating-mother-language-day-in-open-source/>

for women to develop the appropriate skills and mindsets outside male dominated and intense development environments, where they felt undermined. Second, these spaces provided opportunities for connection, mutual support, solidarity, and comradery in a male dominated world. This was particularly important for women who sought to openly discuss and seek advice on issues ranging from discrimination and harassment to work life balance and the demands of growing families.

N., a senior male developer, observed that women who were introduced to open source via these protected spaces appear to have a fundamentally different, more positive experience compared to women who did not have the benefit of such support. M., a male Indian coder, noted that participating in women-only events, such as

the Grace Hopper conference, gave women an amazing source of energy and empowerment as they were able to meet and connect with other successful women. He also observed that women were able to learn from others with similar backgrounds and problems about how to manage their careers, family demands, and other issues.

Although many interviewees emphasized the importance of protected, positive environments, they also reflected on the need to go beyond them. For K., a Kenyan developer, this was achieved by ensuring that AkiraChix trainees took part in mixed gender hackathons. For G., a leading member of FOSSAsia, and other interviewees, this was achieved by engaging with more senior developer male allies.



6. Institutions: established ways of thinking and doing

Some of the established ways of thinking and acting perpetuated by family, schools, and employers undermine diversity in open source. Therefore, addressing these should be part of any solution.

6.1 Family and motherhood

The domestic division of labor and perceptions of the women's role in family and society were important topics for interviewees from sub-Saharan Africa, Southeast Asia and India. D., from Zambia, took a systemic view of the root causes, looking first at the immediate and practical issues women face and then at the institutions that need to change norms, values and policies and support women's right to equal treatment and pay. One interviewee noted the importance of raising boys and girls as equals:

"...I think it would really help if parents would raise their kids to do equal tasks and go get what they are after equally. [Girls should be given] equal opportunities for education and equal time to do their homework."

A married, 28-year-old Indian programmer worried that her family might pressure her to stay home when she decides to have children. Her perception was that it is hard to come back to work after having a baby. She benefits from her encounters at work with colleagues who are successfully managing careers, motherhood and family life. Unfortunately, her family has not had the same exposure, and so she was anxious about what might happen down the road. In Cambodia, one woman contrasted her responsibilities with women in the US who have supportive spouses, noting that one of her American counterparts had a husband who

stayed home to look after their children. This woman had acknowledged she would not have been able to rise to the level she did without that support.

For M., a senior Kenyan developer, societal expectations on appropriate career paths were a barrier for women, with many young people studying subjects in which they were not really interested. She describes the trajectory of one young woman who had to go against her parents' wishes to study computer science rather than medicine. The right family support, however, can be hugely beneficial. D, a Zambian developer, said her parents intervened to let her be allowed to study math at school.

6.2 Pathways and barriers in education

D.'s experience shows the importance of early intervention in institutions such as schools, which tend to reproduce unequal gender norms. This is indicative of the challenges for women globally in science and technology fields. In higher education, women represent only 35% of all students enrolled in STEM-related fields of study. They leave STEM disciplines in disproportionate numbers while still studying in institutions of higher learning, transitioning to their first job and during the lifecycle of their careers.¹⁶

People we interviewed showed a range of strategies to tackle this issue. AkiraChix is addressing this challenge by offering coding classes and STEM clubs at girls' secondary schools in Nairobi. One open source leader in Cambodia was building a "supply chain" of young women by opening up her office space to female students to learn more about their work and cultivate their interest and excitement in pursuing careers in technology. This led to a higher likelihood of women applying to be interns in technology-focused roles. She also encouraged her team to volunteer as mentors and teach young girls about technology. One

interviewee saw a role for donors in funding coding workshops to help schools build a critical mass of women programmers, especially in developing countries.

Given the current constraints, the interviewees widely contested the idea that new programmers would easily be able to pick up the know-how necessary for contributing to open source projects. One interviewee pointed out that in Kenya there is little software development outsourcing so there are fewer opportunities for young programmers to get involved in complex projects and develop their programming skills. Interviewees also highlighted the lack of open source tools, processes, resources and guidance available at many universities.

6.3 Meritocracy and hiring procedures

Positive discrimination and the debate it engenders have a long history in development and social change. Does supporting women's participation justify tilting the scales, for a while, in their favour, even when it may create feelings of resentment among male colleagues who may be better qualified? What effect would this have on women themselves, especially in cases where they were hired specifically to meet gender guidelines and improve the image of an organization or group?

Open source communities claim they are based on a culture of meritocracy, yet many women with whom we spoke reported feeling that they had to work twice as hard as men to have their accomplishments recognized. In a system of meritocracy, the most capable and prolific contributors garner the most influence on how a project develops, including the new features it incorporates and what policies it follows. As new contributors gain more experience and prove their mettle, they rise in the ranks of the community. As such, open source is meant to be gender, race, class and culture agnostic. This

¹⁶ Chavatzia, T. (2017) Cracking the code: girls' and women's education in science, technology, engineering and mathematics (STEM), Paris, France: UNESCO, <http://unesdoc.unesco.org/images/0025/002534/253479E.pdf>

view would be at odds with introducing positive discrimination policies.

Male leaders in open source were committed to the principles of gender equality in theory but were sometimes unwilling to change existing hiring practices. One man we interviewed claimed it was important to look at capacity and technical qualities, not gender, in hiring because positive discrimination could have unintended negative consequences, such as strengthening the impression among men that women were only getting hired because of a community's affirmative action policies. He noted the following:

"It sours the community in a different way. You should try to find a middle ground that allows a healthy work environment for both men and women. That's what I am trying to do."

A Kenyan woman felt that this perception of a meritocracy, however, was false, "I know that people think it [the tech sector] is a meritocracy, but I think it's ego driven."

Mozilla has made a strong commitment to removing meritocracy as a governing principle on the grounds that it served as a barrier to increasing diversity in open source communities. A blog from Ashe Dryden posted on the Ada Initiative¹⁷ site describes meritocracy in open source software as a "romanticized ideal:"

"As the people who exist within this supposed meritocracy don't exist within a vacuum, we also have to realize how our actions affect others... It's a romanticized ideal – a belief which at best ignores and at worst outright dismisses the experiences of everyone outside the group with the most access to these things. A certain demographic of people has three or four steps above other people, so the playing field is not even."

A representative from a company that develops software for the healthcare and development sectors discussed how they are actively pursuing diverse hires and taking a structured,

intersectional approach to addressing under-representation:

"On the engineering team, we are looking for more female candidates of color. On the service design team, we have a significant number of white women so we will not be looking to hire any more onto that team at this time."

Many objections expressed about positive discrimination policies are that it can be a form of "gender washing," a public relations process whereby women are given jobs to improve an organization's image. In Kenya, B., a senior developer, talked about companies hiring women as a way to secure contracts more easily. She also described how companies are hiring women without first testing their skills. They then restrict them from actively contributing to projects.

Another Kenyan woman found it easier to get jobs in coding than her male partner, but she also was uncomfortable being "wheeled out" at events as the lone female developer. The resentment her partner felt at the preferential treatment prospective employers were providing women coders, at least at the hiring stage, should not be underestimated. Most of our Kenyan interviewees confirmed that feelings of resentment are common in the IT job market. Without genuine institutional commitment, follow through, and thoughtful action, women's agency can be limited by the very procedures aimed at increasing gender equality.

6.4 Building healthy open source communities' codes of conduct

Our research found that having a code of conduct is becoming more important rhetorically, and practical palliative measures are being put in place. Interviewees supported these findings but questions remain. Who is putting them in place and is it enough? Who enforces them and how? What if the perpetrator, as one senior developer

¹⁷ Ashe Dryden What's wrong with "meritocracy" in open source software? <https://adainitiative.org/2014/01/24/guest-post-whats-wrong-with-meritocracy-in-open-source-software/>

put it, is a core developer for your project? There is a need to ensure a path for reporting and accountability in codes of conduct, with individuals named and empowered to sanction transgressors if necessary.

Mozilla is undertaking significant work on the issue of codes of conduct, and those on a recent community call examined the issue of dealing with “toxic” members. One open source male leader discussed the success of introducing official moderators who do not have responsibilities on the core team. Another contributor cited the need for such moderators to be remunerated especially since the positions carry a significant burden. A blog post¹⁸ shares Mozilla’s work on building a framework of processes, standards and best practices for response to code of conduct incident reports.

6.5 Global dynamics of open source projects

Women’s participation in open source is not defined solely by gender. Geography, race, and class are some of the additional factors shaping how women across the world experience inclusion and exclusion in this space. A self-taught Kenyan programmer will likely encounter different challenges when participating in open source than a white, relatively affluent computer graduate from the UK. The majority of open source projects originating in the north will also shape the women’s experiences.¹⁹

The “North-South” dynamic, coupled with unrealistic donor and NGO expectations about what it takes for an open source project to thrive, pose significant challenges to open source leaders, especially those in the south. By making software available at a public software repository like GitHub and placing it under an open source software license, many assume a diverse community of developers will automatically emerge to support it. This is an unrealistic expectation in resource-poor environments,

where free time is a luxury and local capacity is not guaranteed.

The experiences of women working in Zambia and Southeast Asia show that open source projects focused on the Global South can help address development challenges and build skills in local development communities. Open source also provides opportunities for people to travel and collaborate with those they would not otherwise meet. For one Zambian woman, working in open source was a springboard to setting up her own IT company; another member of a mapping community in Madagascar was motivated to contribute because of the value of free software tools and platforms, like GIS, to low-income countries.

Several interviewees felt that funding local ecosystems around software projects could also benefit those working in non-technical roles such as project managers, sales people, designers, and requirement gatherers and increase diversity in the overall community. This was proving difficult, however, because of a lack of core funding for their projects. This led one male leader of an international open source project to recommend direct funding support for developers:

“Direct financial support to software developers in target countries would have a strong impact and provide the fastest pathway to success. It would allow us to talk about a story that pushes back both on gender norms and donor recipient mindset.”

As part of the North-South dynamic, it’s important to acknowledge which countries and regions are progressing outside the norm, where women are engaging in software development at higher levels than in the US and Western Europe. For example, one male interviewee observed that in Palestine, software development is seen as a place where women can pursue a professional, well-paid position and work with men on an equal basis without having to interact with them outside

¹⁸ <https://medium.com/mozilla-open-innovation/how-were-making-code-of-conduct-enforcement-real-and-scaling-it-3e382cf94415>

¹⁹ Mombach, T., Tulio Valente, M., Chen, C., Bruntink, M., & Pinto, G. (2018). Open Source Development Around the World: A Comparative Study. arXiv preprint arXiv:1805.01342. <https://arxiv.org/pdf/1805.01342.pdf>

office hours. He saw the same occurrence in Tunisia and Morocco, where he thought the number of women software developers was higher than in the rest of the world. According to a 2015 UNESCO report on the gender gap in science and engineering, Tunisia's percentage of female graduates in technology in 2013 (41.1%) appears to be higher than in many other countries.²⁰

When looking at the North-South dynamics of open source projects, it is also important to consider the special character of many of the projects underway for development purposes such as health or humanitarian software. Many of the projects examined in this study were initiated with core funding from large multilateral agencies and other donors, which dramatically changes the character of participation. Having a funded core team from the start gives momentum to a project but sometimes makes it difficult to attract volunteer contributors as the emphasis is often on delivering results rather than creating

an extended community. This scenario requires a different approach to ensure that local users and external developers are involved from the beginning.

National and local governments have an important role to play in bridging the gender divide in the tech sector. Rwandan government policies on digital development and gender equity, for example, demonstrate that an enabling environment can transform the opportunity landscape for women in open source. Girls in ICT Rwanda mentor other Rwandan girls and convene a MissGeek competition, which is now open to females between 13 and 25 years old in Smart Africa member states.²¹ The government also formalized and integrated the many mentorship programs running in the country. One Rwandan interviewee cited how she had benefited from this positive environment. She has already been active in open source for eight years and is now passing on her expertise to girls through mentoring and training.

²⁰ Huyer, Sophia. "Is the gender gap narrowing in science and engineering." UNESCO science report: towards 2030 (2015): 85. https://en.unesco.org/sites/default/files/usr15_is_the_gender_gap_narrowing_in_science_and_engineering.pdf

²¹ Angola, Benin, Burkina Faso, Cameroon, Chad, Congo DRC, Cote d'Ivoire, Djibouti, Egypt, Gabon, Guinea, Kenya, Mali, Niger, Rwanda, Sao Tome & Principe, Senegal, South Africa, South Sudan, Togo, Tunisia and Uganda



7. Agency: what is working?

Agency is a person's ability to act in pursuit of what they have reason to value. A person's actions are shaped both by subjective and objective factors. Subjectively, a woman may have low self-belief with respect to her own capabilities. Objectively, her ability to act may be restricted by resources such as money or skills; institutional structures such as pervasive gender norms; or organizations with their own unique recruitment and promotion practices. We asked interviewees what experiences they had had that enabled them to flourish in open source environments.

7.1 Gender Norms

Many pioneers in computer programming were women, and it was originally a female-dominated profession.²² Coding today, however,

has become socially constructed as men's work in most countries.²³ This construction of programming as a male preserve discourages women from studying software engineering and becoming coders. The overwhelming majority of those whom we interviewed reported that, in their experience, they were under-represented in coding positions, especially senior roles. This was true for both open-source communities as well as other programming environments. Most interviewees with experience in both open source and closed source coding environments reported that issues of unequal gender representation were equally prevalent in both. While coding in general is perceived as male and geeky, open source is perceived as even geekier with one [male] interviewee characterising it as a boy's club replete with misogyny. His account resonates with several [female] coders who reported that they were

²² Hicks, M. (2017). *Programmed inequality: How Britain discarded women technologists and lost its edge in computing*. MIT Press.

²³ Chavatzia, T. (2017) *Cracking the code: girls' and women's education in science, technology, engineering and mathematics (STEM)*, Paris, France: UNESCO, <http://unesdoc.unesco.org/images/0025/002534/253479E.pdf>

demeaned in open source communities, and in order to fit in at all, they had to endure a sub-culture of sexist language. According to many of our interviewees, the perception of coding as a male preserve made them feel less able to enter the profession, and among those who had experienced abuse, it reduced their agency to pursue their interest and aspiration in open source.

When we asked interviewees about where these gender norms and values originated, they suggested that they are reflections of wider social mores and prejudices. Most interviewees told us that family and teachers steered women away from science, technology, engineering and math (STEM subjects) and encouraged them to pursue subjects such as home economics. In open source workplaces, they told us that leadership pushed women contributors away from coding work and into “house-keeping” roles, in which they were expected to provide support to male coders.

One female interviewee with a degree in computer engineering told us that she had repeatedly reminded line managers of her advanced coding skills to avoid being side-lined. Several women told us that in their experience, the default assumption of managers and clients was that women had little if any coding skills. From these interviews, we learned that women’s agency is negatively affected by pervasive gender norms. These norms are formed from early socialisation experiences, become reinforced through unequal household and childcare responsibilities, and are reproduced in the workplace. Early socialisation by family and teachers deters women from studying computer engineering, and in the workplace, they struggle to deal with the sexist expectations of their male colleagues. In many countries, women come home from a full day’s work only to begin their “second shift” of domestic and childcare responsibilities. The net effect of this discrimination and disadvantage is to sap the agency of women working in open source. Despite this negative picture, research shows a

multiplicity of ways that organizations can support women and address negative socialisation. For example, a UNESCO report²⁴ recommends that governments undertake targeted measures to promote gender equality, such as gender mainstreaming legislation, policies to increase women in specific industries (e.g., quotas), financial incentives, and other actions to increase girls’ and women’s participation in STEM education and careers.

7.2 Emotional labor: working in hostile environments

Interviewees reported a wide variety of both positive and negative experiences in open source communities. Some felt welcomed and supported in organizations that had in place institutional structures of support and care. One woman reported her positive experiences:

“Everyone in the community is very welcoming and friendly. Sometimes it is advantage to be a woman as there aren’t very many of us and as everyone is helpful and wants you to engage.”

Others we interviewed found open source spaces to be unwelcoming or even hostile; an experience which is backed up by research²⁵. Women interviewees experienced discrimination and described feelings of loneliness and alienation stemming from a lack of support. Continuing to work in this context required increased mental and psychological effort, or “emotional labor” among women. Below is a quote reflecting the experience of an open source contributor from West Africa:

“I am the only woman and it is not very good. I feel lonely. Women can do what men do but they need encouragement and men are not friendly with women. They say that women should stay at home to cook and care for children. It is discouraging when they think we can’t do this and should stay at home. Sometimes I start to think that what the men are saying is true, but I know it isn’t and I can help others.”

²⁴ Ibid, p. 22.

²⁵ Reagle, J. M. (2013). “Free as in sexist” Free Culture and the gender gap. First Monday, 18(1). Available at: <https://firstmonday.org/article/view/4291/3381>

One interviewee described feeling sad and angry in the face of systematic discouragement. A senior contributor from South Africa described the pressure to abandon her identity to be accepted:

“It is very different to join an all-male team versus one that is diverse. It goes back to the stereotype of male developers having a very masculine, ‘bro’ culture. It can be uncomfortable for women because of the jokes. It is hard to explain, but it is very different environment where you are not entirely able to be yourself as a woman. One of our other female coders wears trousers and acts a bit more masculine to blend in.”

A black South African woman contributor to a large open source community explained how the color of her skin added a racial dimension to her feelings of alienation. She felt that she had to “morph” and “code switch” to relate to the white male sub-culture of coders. An open source contributor from Cote d’Ivoire perceived her hostile environment as ultimately driven by men’s fear that they might lose their privilege and hierarchical position. Like other women we interviewed, she was able to channel her sense of injustice to fuel her agency and continue fighting:

“They say go home and cook with your mother. I say cooking is not just for women. I am a qualified engineer in telecommunication and informatics like you. It makes me angry. But I don’t shut up and I keep speaking. I want the job. I can’t be behind a man.”

Given the levels of loneliness, alienation and sexist abuse women experience in open source communities, it is not surprising that many leave or avoid it altogether. In environments where men are literally telling women to “go home,” the issue is clear, but even in those that are free of such open hostility, our interviewees reported that a macho culture among open source coders means that women often still feel alienated. The emotional work of having to participate in a “bro culture” to

be accepted means that women contributors are still experiencing open source communities as hostile environments. Interviewees told us that many are not taken seriously and those in online communities often experience aggression and derogatory comments. As a result, they feel they must disguise their gender and adopt gender-neutral names online to avoid the hostility and abuse.

Advocates of women’s rights within this space are frequently a target of abuse. An Indian programmer who also fights for the rights of women and minorities in the peer production space explained how at times, the pressure and hostility she faced led her to take time off to restore her health. The creation of safe and welcoming spaces for new-entrant women coders is one popular intervention from which many of our interviewee had benefited. Google Summer of Code and similar initiatives provide institutional structures for new women coders that positively build their agency and skills in ways that stand in stark contrast to the “welcome” an inexperienced female coder might encounter in the Linux kernel open source community.

These findings drive home the point that “fixing the numbers” of women in open source is necessary but insufficient. It will not end discrimination and disadvantage, nor will it address the abuse they experience due to ethnicity, sexuality or disability. An intersectional approach is necessary to go beyond “counting women” to create safe workplaces.

7.3 Identifying and tackling root causes

This research has identified a range of initiatives that women are successfully using to cope with the discrimination they experience in open source communities. This shows the need for a multifaceted approach which not only provides women with safe spaces, but also engages men as allies and addresses the root causes.

Mentorship, role models and skills training are effective ways to build the agency of women coders. Those who participated in these programs highly valued them. At the same time, it is true that there is no amount of skills training and mentoring of women that will resolve the gender socialisation of young girls and boys, the pervasive gender norms and values it produces, or the toxic masculinity²⁶ of some online open source communities. The initiatives presented are essential to enabling women to cope with adverse circumstances, however, they do not aim to change gender norms and values. They treat the symptoms rather than the cause.

Increasing women's agency is not enough to bring about equality in open source communities. Several gender empowerment approaches go beyond agency to critical agency or what, in the Gates Foundation Framework, is called "critical consciousness."²⁷ In other words, it enables people to analyse social problems and act together to transform them.

From this perspective, removing gender discrimination in open source communities requires stakeholders to identify the deep-seated root-causes and act on them in addition to the symptoms. Programs seeking to transform the situation of women in open source should include safe spaces for women to speak openly about their gender experiences, their causes and solutions. This may require going beyond gender to understand its intersection with other dimensions of exclusion. A South African programmer made an observation about her country and race below:

"South Africa has a very specific history with regard to race relations and that has kept a lot of people out of [the software] industry, not only from an educational standpoint but from the economic means to get that education especially from a class and racial perspective. There are also people [in rural] areas who are not exposed to these types of careers."

Some women we interviewed wanted to include men in such change initiatives. Recognising that men's attitudes and behaviour were the primary obstacle to progress, interviewees sought to go beyond women-only initiatives. Below is a comment from a Zambian programmer reflecting on the need to work with men as well with women to bring about change:

"We have to work with men to ensure they are ready for the next generation of empowered women. A group of us are meeting to work on this. We need to make women equal partners and prepare men for the new breed of women."

Without addressing the structural issues, there is a danger that in ten years' time, we will be having the same conversation about why women are still a minority group in open source despite the expansion of support programs.

²⁶ Toxic masculinity refers to the socially-constructed attitudes that describe the masculine gender role as violent, unemotional, sexually aggressive, and so forth.

²⁷ In the Gates Framework critical consciousness is foundational to women and girls exercising collective and individual agency. Critical consciousness refers to women and girls identifying and questioning how inequalities in power operate in their lives, and asserting and affirming their sense of self and their entitlements.



8. Conclusions and key findings

Our research underscored the importance of increasing the number of women working in open source. We learned about various ways to do this, such as implementing support programs that provide mentoring, female role models, and vocational skills training. Women also highly value taking part in online networks and attending conferences. One interviewee described these types of opportunities, where she was able to meet other women facing the same challenges, share experiences, and exchange advice as exhilarating and kept her going for months. Many stated that they helped them feel less isolated in their male dominated work spaces. Developing a sense of comradery, through group work, to build collective solutions reduced women's sense of isolation and powerlessness.

Some interviewees had experienced initiatives that went one step further and aimed to change the problematic gender norms that shaped the

inequity they saw. The desire to expand work in schools to change perceptions about what constitutes women's versus men's work was a common theme among interviewees, and two organizations had already begun this work. Women also highlighted the need to address the gender norms of male employers, coders, trainers, husbands and family members as a part of removing barriers to women who code.

We developed a typology in Table 2 below to frame the different initiatives promoting women in open source. It combines the Agency-Structure-Resource approach from the Gates Foundation's Gender Empowerment Framework with Roberts' (2015) Conformist-Reformist-Transformist approach.²⁸ The table is intended as a schematic tool only; in practice, activities will straddle boundaries or move among categories over time.

²⁸ Roberts, Tony. "Critical Intent and Practice in ICT4D: A Typology of ICT4D Initiatives." In Proceedings of the 13th International Conference on the Social Implications of Computers in Developing Countries, Negombo, Sri Lanka. 2015.

Conformist initiatives help women to better cope with or accommodate themselves to existing unequal gender relations (without challenging them). Technical skills training for women and some kinds of mentoring fit this category.

Reformist initiatives aim to change existing unequal gendered social relations (but without tackling the underlying power structures that give rise to and sustain them). Codes of conduct and initiatives to increase women speakers fit this category.

Transformist initiatives aim to identify and transform the unequal power structures that are among the root-causes of gender injustice. Critical consciousness work and initiatives that result in women with equal power and control fit this category.

Table 2: Initiatives promoting women in open source

	Resources	Institutional Structures	Agency
Conformist	<ul style="list-style-type: none"> • Skills training • Paid coding work • Conference bursaries 	<ul style="list-style-type: none"> • Voluntary data collection counting women 	<ul style="list-style-type: none"> • Mentoring • Role models • Learning the history of women in computer science
Reformist	<ul style="list-style-type: none"> • Build social capital through online networks and conference sessions for women in open source (particularly) in the Global South 	<ul style="list-style-type: none"> • Codes of conduct • Diversity awareness • Diversity audits 	<ul style="list-style-type: none"> • Women coders in schools • Workplace visits for students to socialise them • Paid internships
Transformist	<ul style="list-style-type: none"> • Make the Open Access Publishing of annual pay and diversity audits a condition of funding and contracting criteria. Donor funding conditional to gender parity and tracking gender indicators/data. 	<ul style="list-style-type: none"> • Achieve gender parity in senior positions of power and control 	<ul style="list-style-type: none"> • Mandatory GBV or anti-harassment training • Critical consciousness programmes for women and men • Enacting policies which change gendered social norms such as coding boot camps initiatives for children

The goal of this matrix is not to argue that any one activity is more important than another; all are valuable. The aim is to stimulate discussion about what additional activities your organization might want to promote to complement your existing work. It could be used to help organizations consider which activities will allow them to achieve more ambitious goals or move in more strategic directions.

We have used the matrix to think through our recommendations for action that each group of actors can take to translate the lessons of this research into practical action.

8.1 Future research

The research identified a number of exciting areas outside the scope of this study that would be productive for future research:

Positive Deviants: There are countries where it is not unusual or “unwomanly” to study software engineering or work as a coder. What factors distinguish the patterns of socialisation and institutional structures in these countries to make it possible for women to pursue coding careers in such favourable circumstances? What lessons are there for the rest of us? It is also the case that in countries where coding is gendered as male there are positive deviants: women who escape or overcome the construction of programming as masculine to become proficient and successful coders. What are the factors that make this possible and what can we learn from them to improve the experiences of other women?

Intersectionality: This study has focused on the challenges of women in open source, but due to its international scope, it quickly became clear that not all women are equal. Gender was only one dimension of women’s disadvantage from the Global South who wished to contribute to open source communities. In South Africa, discrimination on the basis of race and class was fundamental to women’s inclusion and in Francophone Africa, language and funding

patterns added to their exclusion. Further research that recognizes overlapping forms of women’s exclusion in open source is necessary to a comprehensive understanding of their obstacles in open source.

Methods & Tools: Some employers told us that they did not have the practical skills or knowledge to effectively monitor diversity in their organizations or bring about change. Some women told us that there was a need to move beyond single workshops that benefit individuals in the short-term to ongoing programs that generate systemic change. There is certainly a need to raise levels of awareness of, commitment to and action for more structural change. Some open source organizations are currently leading others on this journey. Further research needs to be done with those organizations that have secured commitment and achieved significant progress to capture their learnings and make them available to others in the form of a toolkit of methods and approaches. Carrying out some additional research with women and men at open source conferences to raise critical consciousness and document what works and what does not would be a valuable contribution in moving this agenda forward. It would also be valuable to carry out research and activities targeted directly at men.