Gender in Open Source Software: What the tools tell

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ABSTRACT

This position paper considers what studying Open Source Software tools can lend to understanding the topic of Gender Diversity in Open Source Software. More specifically we investigate the GenderMag method, a Gender Inclusive method and how it can help increase gender inclusiveness in the tools that are used by OSS communities.

CCS CONCEPTS

• **Software and its engineering:**

KEYWORDS

gender, open source software, newcomers

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1 GENDER DIVERSITY IN OPEN SOURCE

What can studying Open Source Software(OSS) tools lend to understanding the topic of Gender diversity in Open Source Software?

Diversity is important for the growth, richness and productivity in any field, and technology is no different. Here we look into the lopsidedness of one type of diversity in the technology - gender diversity. Prior research has shown that Gender Diversity can lead to increased productivity in OSS communities[40].

Computer Science is already a field where women are underrepresented, with NCWIT reporting that a mere 26% of professional computing positions are held by women, despite women making up 57% of the professional occupations workforce[16]. However, women are even more underrepresented in OSS than in the field of computer science as a whole, making up a small percentage (less than 10%) of OSS contributors in the OSS community [12, 33]. Ghosh et al. report an even lower figure: a scant 1.5% of OSS contributors are women [19].

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To investigate this problem, there is a growing amount of research about social/cultural issues that affect women in Open Source communities. As an example, most Open Source communities function as so-called “meritocracies” [14], in which female OSS developers report experiencing the “imposter syndrome” [40]. Participant observation of OSS contributors found that “men monopolize code authorship and simultaneously de-legitimize the kinds of social ties necessary to build mechanisms for women’s inclusion” [29]. In general, cultures that describe themselves as meritocracies tend to be male-dominated cultures that seem unfriendly to women [39]. In fact, acrimonious talk about which code piece should get incorporated leads to the system being a “pushyocracy” instead of a meritocracy, and is a prime reason why women leave OSS communities [29].

All these contributions are important, but it is important to not overlook any of the factors present in OSS, especially when they provide understanding into all the above areas. To this end, the tools that make up technical online communities, like Question Answer(QA) forums or OSS tools are an area in need of more research.

In one example of promising research in this area, Ford et al. identified 14 barriers that affect women by interviewing female newcomers and experienced female online contributors to the QA forum Stack Overflow [18]. They grouped these barriers into three subgroups: 1) Muddy Lens Perspective (how perceptions and expectations serve as barriers); 2) Impersonal Interactions (lack of personal and positive interactions); and 3) On-Ramp Roadblocks (usage barriers that undermine interest) [18]. A later investigation by Ford et al. showed that, because of the dearth of women in technical online communities, women disproportionately experience a lack of a notion they term “peer parity” (seeing other women contributing to their community), but peer parity is important to women’s continued contribution to the community [17].

More on the tool side of these technical online communities is our recent study of OSS tools, including Github, which revealed tool issues that were biased against women [26]. The study presented three insights into OSS tools that warrant further exploration: 1) Tools and infrastructure revealed issues far beyond tool bugs and UI issues; rather, they revealed a wide range of issues across a socio-technical spectrum 2) Tool issues were implicated in newcomer barriers, encompassing six categories of newcomer barriers. 3) The tools and infrastructure were implicated in gender biases. This may play a role in why women are underrepresented in OSS.

2 THE GENDERMAG METHOD

In our study OSS professionals used a method called GenderMag to evaluate the OSS tools [26]. GenderMag uses gendered personas which have embedded facets of problem solving that have been

Figure 1: The Abby persona used in our study [26]

found to cluster by gender to find gender inclusiveness issues in software [3].

The five facets of problem solving in GenderMag are:

- (1) The *motivations* of females to use technology are statistically more likely to be for what it helps them accomplish, whereas for males it is more likely to be for their interest and enjoyment of the technology itself [2, 4, 6, 15, 21, 23, 35].
- (2) Females statistically have lower *computer self-efficacy* than males within their peer sets, which can affect their behavior with technology, causing females to be less confident in their ability to complete tasks and blame themselves if there is a problem. [2, 4, 7, 15, 20, 22, 30, 31, 36].
- (3) Females tend statistically to be more *risk-averse* than males, and risk aversion in technology can impact users' decisions as to which feature sets to use. [9, 13, 41]
- (4) Statistically, more females than males *process information* comprehensively — gathering fairly complete information before proceeding — but more males than females use selective styles — following the first promising information, then backtracking if needed [10, 11, 27, 28, 32].
- (5) Females are statistically more likely to prefer learning software features using process-oriented *learning styles* and less likely than males to prefer learning new software features by playfully experimenting ("tinkering") [2, 5, 8, 21, 34].

GenderMag uses personas along with a specialized Cognitive Walkthrough (CW) to systematically evaluate software [37, 42]. The CW is an inspection method that allows for a wide array of people, from software developers to designers to identify usability issues that would affect new users of a software. Based on empirical

research, CW's have a low false positive rate, meaning that a high percentage of the issues identified are valid usability issues. For example, Mahatody's survey reports false positive rates ranging from about 5% to about 10% [25]; meaning that CWs are about 90% reliable at finding issues. The GenderMag CW has also shown higher than 90% reliability at finding issues and has shown 81% reliability at predicting which of these issues are gender inclusiveness issues [3]. Further, following up on the problems found by GenderMag can lead to more inclusive tools and environments [1, 3, 24].

Our study used the gendered persona "Abby" and gave her the background of OSS newcomer (Figure 1). Using GenderMag with Abby, the software professionals in our study found not only gender inclusiveness issues, but also newcomer issues, suggesting that the process was useful on both fronts. One possibility is that by performing GenderMag, the participants gained knowledge about gender inclusiveness and by using it in an OSS setting, the participants — and we — gained new understanding of problems relating to OSS newcomers, especially problems that would disproportionately affect men or women in OSS.

The software professionals in our study found issues with their own OSS projects[26]. Some examples are shown in Table 1, which shows instances where facets and newcomer barriers emerged. The newcomer barriers are those discovered by Steinmacher et al. [38] where he discovered six categories containing 58 newcomer barriers.

These six categories are:

- (1) Newcomers Orientation (NO)
- (2) Newcomers Characteristics (NC)
- (3) Reception Issues (RI)
- (4) Cultural Differences (CD)
- (5) Documentation Problems (DP)
- (6) Technical Hurdles (TH)

What is notable is that all five of Abby's facets were used frequently across all teams and in different use cases. For example Team-V was working on cloud computing software and using Github issue tracker to find an issue when they mention information processing style and risk(row one of Table 1) whereas Team-Y was working to setup the environment of their graph database OSS project and also found problems pertaining to risk(row seven of Table 1). Overall, all six categories were tied to multiple facets.

3 CALL TO ACTION: SHATTERING THE GLASS FLOOR

From these two examples it is clear that OSS tools are a contributing factor in the gender disparity in OSS.

If the tools are a contributing factor to the gender disparity in OSS, they should be fixable. It can be an immense task to make a community more inclusive, but by comparison, making software inclusive is more tractable.

We believe that by starting to investigate how we can make the tools and infrastructure more gender inclusive, we may not only help increase gender diversity in OSS communities, but also in other areas of tech development. This increase may in turn

Table 1: The software professionals found issues that mapped to both newcomer barriers and facets.

Team/Quote	Barrier Categories [38]						Facets				
	NO	NC	RI	CD	DP	TH	M	Info	SE	Risk	L-PT
Team V-P60: "Yeah so instead of taking any issue and just trying to work on it she will find out more about it so that is attitude toward risk and information process... "	✓	✓						✓		✓	
Team V-P60: "...she might blame herself right now"	✓	✓	✓	✓	✓	✓			✓		
Team V-P59: "...that effects how she might perseveres with a task...though she's tried understanding, there is really not much she could work with"		✓	✓	✓	✓	✓					
Team W-P52: "Oh oh first thing's to sign the CLA. Didn't she (Abby) say something about taking risk ? Something about... she might be worried. "	✓	✓			✓				✓		
Team W-P53: "so she definitely likes to, umm gather information before... "	✓			✓				✓			
Team X-P62: "...Abby would probably prefer a less daunting task...[which] might take a while because she has comprehensive information process-ing... [and] her computer self efficacy might hold her back..."	✓	✓						✓	✓	✓	
Team X-P62: "...I think that maybe her motivations might be something because she... learns new technologies when she needs to but she prefers to use methods already available and comfortable... "	✓	✓					✓				
Team Y-P55: "Well it looks to be cautious because if she pushes something wrong she can mess-up..."	✓				✓	✓				✓	
Team Z-P57: "...she doesn't like to learn by doing...she wants to follow the steps "	✓	✓			✓			✓			✓

create a feedback loop that promotes additional diversity in the tech community.

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REFERENCES

- [1] Margaret Burnett, Robin Counts, Ronnette Lawrence, and Hannah Hanson. 2017. Gender HCI and Microsoft: Highlights from a Longitudinal Study (VL/HCC2017).
- [2] Margaret Burnett, Scott D. Fleming, Shamsi Iqbal, Gina Venolia, Vidya Rajaram, Umer Farooq, Valentina Grigoreanu, and Mary Czerwinski. 2010. Gender Differences and Programming Environments: Across Programming Populations. In *Proceedings of the 2010 ACM-IEEE International Symposium on Empirical Software Engineering and Measurement (ESEM '10)*. ACM, New York, NY, USA, Article 28, 10 pages. <https://doi.org/10.1145/1852786.1852824>
- [3] Margaret Burnett, Simone Stumpf, Jamie Macbeth, Stephann Makri, Laura Beckwith, Irwin Kwan, Anicia Peters, and William Jernigan. 2016. GenderMag: A Method for Evaluating Software's Gender Inclusiveness. *Interacting with Computers* 28, 6 (2016), 760–787. <https://doi.org/10.1093/iwc/iwv046>
- [4] Margaret M. Burnett, Laura Beckwith, Susan Wiedenbeck, Scott D. Fleming, Jill Cao, Thomas H. Park, Valentina Grigoreanu, and Kyle Rector. 2011. Gender Pluralism in Problem-solving Software. *Interacting with Computers* 23, 5 (Sept. 2011), 450–460. <https://doi.org/10.1016/j.intcom.2011.06.004>
- [5] Jill Cao, Kyle Rector, Thomas Park, Scott Fleming, Margaret Burnett, and Susan Wiedenbeck. 2010. A Debugging Perspective on End-User Mashup Programming. In *Proceedings - 2010 IEEE Symposium on Visual Languages and Human-Centric Computing, VL/HCC 2010*. 149–156.
- [6] Justine Cassell. 2003. Genderizing Human-Computer Interaction. In *The Human-computer Interaction Handbook*. Julie A. Jacko and Andrew Sears (Eds.). L. Erlbaum Associates Inc., Hillsdale, NJ, USA, 401–412. <http://dl.acm.org/citation.cfm?id=772072.772100>
- [7] Ana-Maria Cazan, Elena Cocoradă, and Cătălin Ioan Maican. 2016. Computer Anxiety and Attitudes Towards the Computer and the Internet with Romanian High-school and University Students. *Comput. Hum. Behav.* 55, PA (Feb. 2016), 258–267. <https://doi.org/10.1016/j.chb.2015.09.001>
- [8] Shuo Chang, Vikas Kumar, Eric Gilbert, and Loren G. Terveen. 2014. Specialization, Homophily, and Gender in a Social Curation Site: Findings from Pinterest. In *Proceedings of the 17th ACM Conference on Computer Supported Cooperative Work; Social Computing (CSCW '14)*. ACM, New York, NY, USA, 674–686. <https://doi.org/10.1145/2531602.2531660>
- [9] Gary Charness and Uri Gneezy. 2012. Strong Evidence for Gender Differences in Risk Taking. *Journal of Economic Behavior & Organization* 83, 1 (2012), 50–58. <https://doi.org/10.1016/j.jebo.2011.06.007>
- [10] Constantinos K. Coursaris, Sarah J. Swierenga, and Ethan Watrall. 2008. An Empirical Investigation of Color Temperature and Gender Effects on Web Aesthetics. *J. Usability Studies* 3, 3 (May 2008), 103–117. <http://dl.acm.org/citation.cfm?id=2835567.2835569>
- [11] William K. Darley and Robert E. Smith. 1995. Gender Differences in Information Processing Strategies: An Empirical Test of the Selectivity Model in Advertising Response. *Journal of Advertising* 24, 1 (1995), 41–56. <http://www.jstor.org/stable/4188961>
- [12] Paul A. David and Joseph S. Shapiro. 2008. Community-based production of open-source software: What do we know about the developers who participate? *Information Economics and Policy* 20, 4 (2008), 364–398. <https://doi.org/10.1016/j.infoecopol.2008.10.001> Empirical Issues in Open Source Software.
- [13] Thomas Dohmen, David Huffman, Jörn Schupp, Armin Falk, Uwe Sunde, and Gert Wagner. 2011. Individual Risk Attitudes: Measurement, Determinants, and Behavioral Consequences. *Journal of the European Economic Association* 9, 3 (2011), 522–550. <http://www.jstor.org/stable/25836078>
- [14] Joseph Feller and Brian Fitzgerald. 2000. A Framework Analysis of the Open Source Software Development Paradigm. In *Proceedings of the Twenty First International Conference on Information Systems (ICIS '00)*. Association for Information Systems, Atlanta, GA, USA, 58–69. <http://dl.acm.org/citation.cfm?id=359640.359723>
- [15] Allan Fisher and Jane Margolis. 2002. Unlocking the Clubhouse: The Carnegie Mellon Experience. *SIGCSE Bull.* 34, 2 (June 2002), 79–83. <https://doi.org/10.1145/543812.543836>
- [16] National Center for Women and Information Technology. 2016-2017. NCWIT By the Numbers. (2016-2017). <https://www.ncwit.org/bythenumbers> Accessed: 2018-3-14.
- [17] Denae Ford, Alisse Harkins, and Chris Parnin. 2017. Someone Like Me: How Does Peer Parity Influence Participation of Women on Stack Overflow? (VL/HCC2017).
- [18] Denae Ford, Justin Smith, Philip J. Guo, and Chris Parnin. 2016. Paradise Unplugged: Identifying Barriers for Female Participation on Stack Overflow. In

- Proceedings of the 2016 24th ACM SIGSOFT International Symposium on Foundations of Software Engineering (FSE 2016)*. ACM, New York, NY, USA, 846–857. <https://doi.org/10.1145/2950290.2950331>
- [19] R. Ghosh, A. Glott, B. Krieger, and B. Robles. 2002. Free/Libre and Open Source Software: Survey and Study (FLOSS), Final Report, Part IV: Survey of Developers. (2002).
- [20] Kathleen Hartzel. 2003. How Self-efficacy and Gender Issues Affect Software Adoption and Use. *Commun. ACM* 46, 9 (Sept. 2003), 167–171. <https://doi.org/10.1145/903893.903933>
- [21] Weimin Hou, Manpreet Kaur, Anita Komlodi, Wayne G. Lutters, Lee Boot, Shelia R. Cotten, Claudia Morrell, A. Ant Ozok, and Zeynep Tufekci. 2006. "Girls Don't Waste Time": Pre-adolescent Attitudes Toward ICT. In *CHI '06 Extended Abstracts on Human Factors in Computing Systems (CHI EA '06)*. ACM, New York, NY, USA, 875–880. <https://doi.org/10.1145/1125451.1125622>
- [22] Ann Huffman, Jason Whetten, and William Huffman. 2013. Using technology in higher education: The influence of gender roles on technology self-efficacy. *Computers in Human Behavior* 29, 4 (July 2013), 1779–1786. <https://doi.org/10.1016/j.chb.2013.02.012>
- [23] Caitlin Kelleher. 2009. Barriers to Programming Engagement. *Advances in Gender and Education* 1 (2009), 5–10. http://www.mrcad.org/Web_Kelleher.pdf
- [24] Michael Lee. 2015. Teaching and Engaging with Debugging Puzzles. (2015).
- [25] Thomas Mahatody, Mouldi Sagar, and Christophe Kolski. 2010. State of the Art on the Cognitive Walkthrough Method, Its Variants and Evolutions. *International Journal of Human-Computer Interaction* 26, 8 (2010), 741–785. <https://doi.org/10.1080/10447311003781409> arXiv:<http://dx.doi.org/10.1080/10447311003781409>
- [26] Christopher Mendez, Hema Susmita Padala, Zoe Steine-Hanson, Claudia Hilderbrand, Amber Horvath, Charles Hill, Logan Simpson, Nupoor Patil, Anita Sarma, and Margaret Burnett. 2018. Open Source barriers to entry, revisited: A sociotechnical perspective. (2018).
- [27] Joan Meyers-Levy and Barbara Loken. 2015. Revisiting gender differences: What we know and what lies ahead. *Journal of Consumer Psychology* 25, 1 (2015), 129–149. <https://doi.org/10.1016/j.jcps.2014.06.003>
- [28] Joan Meyers-Levy and Durairaj Maheswaran. 1991. Exploring Differences in Males' and Females' Processing Strategies. *Journal of Consumer Research* 18, 1 (1991), 63–70. <http://www.jstor.org/stable/2489485>
- [29] Dawn Nafus. 2012. 'Patches don't have gender': What is not open in open source software. *New Media & Society* 14, 4 (2012), 669–683. <https://doi.org/10.1177/1461444811422887>
- [30] Anne O'Leary-Kelly, Bill Hardgrave, Vicki McKinney, and Darryl Wilson. 2004. The influence of professional identification on the retention of women and racial minorities in the IT workforce. In *NSF Info. Tech. Workforce & Info. Tech. Res. Pl Conf (NSF '04)*. 65–69. <https://www.nsf.gov/cise/cns/cwardle/itwf03.jsp>
- [31] PiazzaBlog. 2015. STEM confidence gap. (January 2015). <http://blog.piazza.com/stem-confidence-gap/>
- [32] René Riedl, Marco Hubert, and Peter Kenning. 2010. Are There Neural Gender Differences in Online Trust? An fMRI Study on the Perceived Trustworthiness of Ebay Offers. *MIS Q.* 34, 2 (June 2010), 397–428. <http://dl.acm.org/citation.cfm?id=2017458.2017469>
- [33] Gregorio Robles, Laura Arjona Reina, Alexander Serebrenik, Bogdan Vasilescu, and Jesús M. González-Barahona. 2014. FLOSS 2013: A Survey Dataset About Free Software Contributors: Challenges for Curating, Sharing, and Combining. In *Proceedings of the 11th Working Conference on Mining Software Repositories (MSR 2014)*. ACM, New York, NY, USA, 396–399. <https://doi.org/10.1145/2597073.2597129>
- [34] Daniela Rosner and Jonathan Bean. 2009. Learning from IKEA Hacking: I'M Not One to Decoupage a Tabletop and Call It a Day. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '09)*. ACM, New York, NY, USA, 419–422. <https://doi.org/10.1145/1518701.1518768>
- [35] Steven John Simon. 2000. The Impact of Culture and Gender on Web Sites: An Empirical Study. *SIGMIS Database* 32, 1 (Dec. 2000), 18–37. <https://doi.org/10.1145/506740.506744>
- [36] Anil Singh, Vikram Bhadauria, Anurag Jain, and Anil Gurung. 2013. Role of gender, self-efficacy, anxiety and testing formats in learning spreadsheets. 29 (05 2013), 739–746.
- [37] Rick Spencer. 2000. The Streamlined Cognitive Walkthrough Method, Working Around Social Constraints Encountered in a Software Development Company. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '00)*. ACM, New York, NY, USA, 353–359. <https://doi.org/10.1145/332040.332456>
- [38] I. Steinmacher, A. P. Chaves, T. U. Conte, and M. A. Gerosa. 2014. Preliminary Empirical Identification of Barriers Faced by Newcomers to Open Source Software Projects. In *2014 Brazilian Symposium on Software Engineering*. 51–60. <https://doi.org/10.1109/SBES.2014.9>
- [39] Sherry Turkle. 2005. *The Second Self: Computers and the Human Spirit*. Simon & Schuster, Inc., New York, NY, USA.
- [40] Bogdan Vasilescu, Daryl Posnett, Baishakhi Ray, Mark G.J. van den Brand, Alexander Serebrenik, Premkumar Devanbu, and Vladimir Filkov. 2015. Gender and Tenure Diversity in GitHub Teams. In *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems (CHI '15)*. ACM, New York, NY, USA, 3789–3798. <https://doi.org/10.1145/2702123.2702549>
- [41] Elke U. Weber, Ann-Renée Blais, and Nancy E. Betz. 2002. A domain-specific risk-attitude scale: measuring risk perceptions and risk behaviors. *Journal of Behavioral Decision Making* 15, 4 (2002), 263–290. <https://doi.org/10.1002/bdm.414>
- [42] Cathleen Wharton, John Rieman, Clayton Lewis, and Peter Polson. 1994. The Cognitive Walkthrough Method: A Practitioner's Guide. In *Usability Inspection Methods*, Jakob Nielsen and Robert L. Mack (Eds.). John Wiley & Sons, Inc., New York, NY, USA, 105–140. <http://dl.acm.org/citation.cfm?id=189200.189214>