Gender and Volunteer Computing

A Survey Study

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***Abstract*—Volunteer computing is a form of citizen science that has a significant gender imbalance. Far fewer women than men participate; women are typically less than ten percent of a project's participants. To better understand the experience of women in volunteer computing and seek clues as to methods for using volunteer computing experience as a recruiting tool, we analyze participant survey data from a project that tries to engage new communities with an interactive infrastructure. Our results showed very few gender differences among the responding men and women in volunteer computing. Our findings add to evidence that men and women engaged in computing activities are overwhelmingly similar. The challenge for gender balance seems to be informing and engaging larger networks of diverse women to promote volunteer computing and contribute to achieving its goals.**

Keywords—volunteer computing; gender; women; representation; recruitment

I. INTRODUCTION

Volunteer computing (VC) allows people to donate their computing resources, such as storage or processing power, towards massive, often altruistic, projects. Despite VC's worthy goals and easy open participation, it has an even more substantial gender imbalance than most other areas of computing. Far fewer women than men participate in VC; women are typically less than 10% of a project's participants.

ExSciTecH is a project with the ultimate goals of advancing science; educating and diversifying participants in the VC project, Docking@home (D@H), which aims to assist with designing new drugs for breast cancer and HIV; and ultimately attracting more women to the study of computing. To increase volunteer engagement, ExSciTech is developing a Wii-like gaming interface for interactive protein-ligand docking simulations. The question remains, however, whether this technical solution for broadening appeal will overcome the persistent and widespread lack of women volunteers in the VC community.

This paper reports findings from an anonymous survey of D@H website visitors. Survey results show a severe lack of women among respondents, but there were also very few gender differences among the participants. For example, we found no statistically significant differences in participants' self-rated ability to contribute to VC projects. The majority of both sexes also reported experiencing no obstacles to their participation. Likewise, men and women exhibited no measurable differences in their reasons for being interested in VC. These findings suggest that men and women who engage in computing activities such as VC may be even more similar than men and women in the general population. More specifically, our survey results indicated that 50% of the male and female student respondents were interested in taking a course in computing as a result of volunteering, but when student status was not controlled, men on average were more interested than women in majoring or working in computing.

Local conditions and practices can overcome cultural believes and lack of information that contribute to women's underrepresentation in computing. Prior research shows that people select interest based on factors including efficacy, sense of belonging, and identities [14]. Active recruiting tends to capitalize on these factors.

One of the major practices we recommend is to align women's existing interests with computing activities. If volunteering interests women, VC potentially interests them too. It might be effective to use VC as an entry for women's engagement in the study of computing. There is no empirical evidence for women actually increasing their desire to create as a result of active recruiting. It provides an opportunity to manipulate the enrollment process some and that would be a low entry barrier to sparkle interests.

The challenge for this approach to making a positive impact on gender balance in computing education seems to be informing and engaging larger networks of diverse young women in VC. In this paper, we argue that women may be enrolled in VC when current participants have the motivation and means to do so.

II. GENDER AND VOLUNTEER COMPUTING

A. Volunteer Computing

Volunteer computing is an application of distributed computing in which a large complex computing task or problem is broken down into smaller units. A network of volunteers and their computers then tackle these units to find a solution. In VC, private citizens donate idle computer time to solve the problem units. The volunteer's personal computer becomes part of a network with other volunteers' computers

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and the project host server. The server is responsible for breaking computation problems into smaller units, sending these units to volunteers' computers, and verifying that reasonable results are returned by volunteers. Additionally, volunteers can participate in simulation activities that lead to scientific discoveries.

The interface between the project server and the volunteer is the Berkeley Open Infrastructure for Network Computer platform (BOINC). BOINC is financially supported by the National Science Foundation and is used by most of the VC projects, including IBM's World Community Grid (WCG) program.

BOINC minimizes interaction between the volunteer as a person and the project itself, which generates certain dynamics within the volunteer computing community. Volunteers assume that projects are non-malicious and will use the provided results in an ethical manner. For their part, projects assume that large groups of volunteers will not conspire to feed a project inaccurate results.

In particular, the ExSciTech project develops methods for engaging new communities as volunteer citizen scientists and builds a mutually beneficial infrastructure for interaction with professional scientists in biology and medicine within VC [6]. The activities provided in ExSciTecH benefit volunteers as they learn basic scientific concepts through interactive discovery and develop a greater interest in the potential of distributed computing. Simultaneously, scientific research is aided by human intuition, and is boosted by the increase in the number of computer cycles donated by more committed volunteers. ExSciTecH is evaluated in terms of its ability to increase the interest and participation of diverse populations in computer science (CS) in general and VC projects in particular, its ability to build inclusive communities of diverse volunteers with different profiles and diverse demographics, and its ability to increase knowledge of science.

Most research about VC focuses on technical issues, for example, programmability and performance, security and reliability [4, 11]. Scholars recently started examining VC participants' motivations [9, 10], applying social psychology research on motivations for volunteering in general. This research has not taken into consideration the accessibility issue in VC, i.e., the design of the user interface or ease-of-use. Therefore, it does not take into consideration the influence of VC technology on human actors. Research that considers social factors [5, 8], such as how social networks (such as Facebook) could facilitate the recruitment of volunteers have not yet considered the role of gender. Our study examines these thus far overlooked issues of technology and gender to explore their potential influence on women's under representation in VC and the potential for using VC as an avenue to improved gender balance in the study of computing.

The potential of volunteer computing is widely praised [1, 2, 7, 15]. SETI@home has utilized volunteer computing to perform the equivalent of roughly 300 years of supercomputer calculations on collected data. Much of the VC potential remains untapped. Currently, only 0.1% of internet users are also active volunteers of VC projects[1] in North America. The available demographics of this miniscule volunteer computing community suggest that 90% or more of participants are male.

B. *Motivation for Drawing Women to VC*

Setting aside the obvious and essential issue of equity, simple volume of participants motivates attracting women to engage in VC. More participants raise productivity, so participant enrollment and retention benefit this form of scientific research. Were women included, volunteer numbers could double.

All VC projects experience a common lack of women volunteers. According to an online poll that received more than 140,000 responses, the most popular VC project SETI@home reported a little over 7% of women volunteers [12]. ExSciTecH has a consistent 5% of women survey respondents from 2010 to 2014. Folding@home, another VC project currently under study using a survey method, has roughly 2% women respondents, although this percentage may not sufficiently represent the overall gender ratio, given the extremely low response rate (about 0.25%). IBM's recent study of their WCG project yielded a lackluster result of 10% women [13]. Because volunteers frequently join new projects, the low number of women in any one project tends to translate into fewer women joining additional VC projects.

C. *Research Questions*

To better understand gendered VC volunteerism and its potential implications for the study of computing, this paper addresses the following questions and whether the answers differ by gender or student status:

- Who are the D@H volunteers?
- What motivates volunteering?
- What inhibits volunteering?
- How confident are volunteers in their ability to contribute?
- How much and variable are volunteers' interests in STEM fields?
- Does D@H experience have any impact on volunteers' interest in the study of computing?

III. DATA ANALYSIS AND RESULTS

An anonymous survey is available on the website for the D@H project. Aside from the visible link, volunteers were invited to respond via several established communication channels for the project. From 2011 to 2014, we received a total of 1628 survey responses, with varying levels of missing data on each variable.

In addition to demographic questions, we collected answers in the following areas: reasons for participating in D@H, obstacles that deter participants from volunteering, whether or not this VC experience increased their interests related to

[1] When assuming all BOINC volunteers are from North America. If looking at world internet user population, this percentage drops to 0.01%.

computing, their self-rated ability to contribute to D@H, and their self-rated interested in STEM fields of study.

In each of the following sub-sections, we analyze corresponding data using descriptive statistics and tests of variance.

A. Who are the D@H volunteers?

An overwhelming majority of D@H volunteers were male (94% of 1248). Most were members of the ethnic majority in their country (80% of 1236) and about half were younger than 45. Only about one quarter of the respondents were students, which implies that the group most likely to gain motivation to study computing are currently not a large portion of the D@H community.

In the following sub-sections, we compare men and women, students and non-students. Participants who chose "other" for gender and/or "decline to respond" for student status were excluded from group comparisons.

B. What motivates volunteering?

We asked volunteers why they were interested in VC. The top three reasons among 1237 respondents were:

1) I would like to help advance science in general (86%)
2) I am interested in the D@H goals (67%)
3) Participating in D@H is fun (32%)

Women (N = 65) and men (N = 1172)[2] exhibited no differences in their top choices. They were only significantly different in their choice of "Other people I know are participating" as a reason for volunteering - 12% of women chose this reason and 6% of men chose it ($p = .03$). The gender difference in this uncommon reason for volunteering persisted when previous VC experience and student status were controlled. This result shows that although the influence was true for a small portion of women, they were more likely than men to be influenced by their peers, regardless of their previous VC experience and student status.

When comparing students (N= 296) and non-students (N = 955), the top choices also stayed the same. These two groups differed only in the choice of "I want to advance my career". Again, a small portion (6%) of the student respondents chose "I want to advance my career" and only 1% of non-student respondents chose it ($p = .00$).

[2] Not all respondents answered the question about their gender, therefore the total N is smaller than the N for the survey as a whole. Because of the drastically different group sample sizes, we use a comprehensive approach to determine whether or not the assumption of equal variance was supported: test of homogeneity of variances (Levine's and Box's M tests), robust tests of equality of means (Brown-Forsythe's test), and comparison of variances across groups. In this paper, we only report results when the assumption of equal variance is supported.

C. What inhibits volunteering?

A majority (69% of 1237) of respondents indicated that they experienced no obstacles to participating in D@H. The next most frequent response was "Other" (11%) and specified mainly technical difficulties[3] and lack of feedback on research outcomes. The rest of the choices received less than 5% responses each. Comparisons between men and women showed no significant difference in their choices of obstacles. For example, 72% women (N = 65) reported no obstacles while 69% men (N = 1172) did so. This lack of gender difference held when previous VC experience and student status were controlled.

When comparing students (N = 296) and non-student volunteers (N = 955), there were still no significant differences in the experience of obstacles. There were also no major obstacles reported, although there were some student/non-student differences in concerns.

- Privacy (7% student, 3% non-student, $p = .00$),
- I don't think that the project will produce scientific results (7% student, 2% non-student, $p = .00$),
- Concerns about Security (4% student, 2% non-student, $p = .02$).

When taking previous VC experience into consideration, there were significantly more experienced volunteers reporting no obstacles. Again, however, neither group reported many obstacles at all.

D. Confidence in Ability to Contribute

Participants were asked to rate their own ability to contribute to VC on a 1-4 scale (1= poor ability, 4 = excellent ability). Overall, respondents selected good or excellent (80%), and no significant gender differences were found.

E. Interest in STEM fields

Among women involved in VC, there were substantial, although not always majority portions interested in science, technology, engineering, and mathematics (STEM) disciplines. The sciences were most appealing; with 84% of responding women indicating that they were moderately or very interested. Computing also enjoyed a much higher than normal level of interest, with 71% of responding women indicating there were moderately or very interested. Finally, only 43% and 44% of the women indicated much interest in mathematics or engineering, but for engineering, that was a very high rate. Nevertheless, as Table I shows, significantly greater portions of men were interested in each of these STEM fields.

TABLE I. GENDER DIFFERENCES IN SELF-RATINGS

How would you rate your		N	% Moderately	Gender Difference

[3] Participants reported technical difficulties such as incompatibility between VC software and Mac OS. As of 2014, this specific problem no longer exists.

interest in…			or Very Interested[4]	(p)
The study of computers	Men	1159	88%	***.00***
	Women	65	71%	
Mathematics	Men	1140	61%	***.00***
	Women	65	43%	
Any of the Engineering Fields	Men	1139	76%	***.00***
	Women	63	44%	
Sciences	Men	1155	95%	***.04***
	Women	64	84%	

F. Impact of VC Experience

We asked participants whether or not VC experience increased their interests in computing as either a profession or an area of study. The majority of the answers were not positive, although one should keep in mind that the overall levels of interest are higher than in the general population, or even college population as evidenced by computing's share of academic majors and employment.

Among the responding sample, 34% became more interested in having a career working with computers. Only 28% became more interested in taking a course involving computers. Only 18% became more interested in applying to a degree program in computer science. When students alone were considered, the responses were more promising, even when gender was taken into account. Tables II and III show gender differences among all participants as well as differences between male and female students.

On the whole, men indicated more increased interest than women in studying and working with computers as a consequence of their experience with D@H. Table II makes clear, however, that as many women as men indicated increased interest in taking a course that involved computers. In this respect, D@H opened the door for attracting more women to the study of computing. When student status was taken into consideration, that potential for recruiting women through VC became even greater.

TABLE II. GENDER DIFFERENCES: HAS YOUR VC EXPERIENCE INCREASED YOUR INTEREST IN…

Gender		%Yes	Gender Difference (p)
Having a career working with computers?	Men	34%	***0.03***
	Women	20%	
Applying to a degree program in computer science?	Men	18%	***0.00***
	Women	3%	
Taking a course involving computers?	Men	28%	0.66
	Women	25%	

TABLE III. GENDER DIFFERENCES IN VC IMPACT AND STUDENT STATUS

Are you a student (either full time or part time)?			%Yes	Gender Difference (p)
No	Having a career working with computers?	Men	30%	0.12
		Women	18%	
	Applying to a degree program in computer science?	Men	11%	***0.00***
		Women	0%	
	Taking a course involving computers?	Men	21%	0.38
		Women	14%	
Yes	Having a career working with computers?	Men	46%	0.15
		Women	25%	
	Applying to a degree program in computer science?	Men	40%	***0.00***
		Women	8%	
	Taking a course involving computers?	Men	50%	0.99
		Women	50%	

Table III illustrates the portions of men and women students and non-students who indicated that the influence of their VC experience. It shows that among students, half of all women (the same portion as men) were more interested in taking a course that involved computers as a consequence of their engagement with D@H. Again, however, this positive impact only extended to trying that first course.

IV. DISCUSSION

The scarce number of women VC volunteers differs from men in limited ways. Our survey results indicate that women and men volunteers share the same motivations for participating, report few to no obstacles in their VC activities, and rate their ability to contribute at similar high levels.

Among those of an age to change their course of study and career, VC activities can impact volunteer's interest in computing. VC also posts limited obstacles for current volunteers. This potential makes worthwhile deliberate efforts to engage more women in VC.

Recent efforts to facilitate enrollment of more diverse participants include media exposure and incorporating VC with mobile devices. For example, IBM's WCG project has the staff and funding that make possible the best web design and publicity among all VC projects. Since their project launch in 2004, WCG has appeared on popular websites such as Youtube and BBC.com, as well as a number of newspapers and technical journals in several different languages, including The Guardian, Financial Times, Wall Street Journal, New York Post, Washington Post, and MIT Technology Review. NSF sponsored VC projects typically do not have such wide media exposure.

"Going mobile" is a trend in both online game and VC developments. VC developers hypothesize that the use of mobile devices will increase the participation of VC volunteers, in the same way it increased the number of online gamers. BOINC lab at UC Berkeley has made a VC platform accessible to mobile device users as well as potential VC volunteers who were not exposed to VC previously. BOINC

[4] Interest was rated on a 1-4 scale: 1 = Not interested at all, 4 = Very interested. Percentages reported are moderately interested and very interested combined.

software is also installed on new Sony VAIO computers to facilitate the WCG project.

The BOINC Android App launched in July 2013 by BOINC lab with a joint press release from the National Science Foundation, UC Berkeley, IBM, and the Max Planck Institute. Folding@home was available on Sony PlayStation 3 console since May 2007. It was removed in Oct 2012, after reaching 100 million volunteered hours. There are no publicly available user data related to any of the above programs and their impact on VC volunteers. As a result, we cannot tell whether "going mobile" has helped VC to achieve gender balance. Considering the already balanced gender ratio in mobile and social gaming, however, it may be that diversity in VC applications will increase the diversity among VC volunteers.

V. CONCLUSION

The VC project studied here appears to have potential for attracting female students to the study of computing. Capitalizing on that capacity requires attracting more women to VC, however. Thus far, the relatively small number of women engaged in VC came to it through the same avenues as their male cohorts. Given that men and women often have different social networks, it might be useful to deliberately engage female networks and communicate messages that counter concerns such as privacy and time commitments. Raising the visibility of VC projects such as D@H among biology students might also attract a new group of participants through aligning the goals and interests of the project and the students in that discipline. Biology is one science with substantial numbers of undergraduate women, so there might be strong appeal for advancing knowledge in that field. Finally, a broader audience could be drawn to VC through the greater availability of its software on popular devices used by both men and women. This dispersal is underway and holds promise for greater diversity in computing.

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