Gender Differences in Graphic Design Q&As: How Community and Site Characteristics Contribute to Gender Gaps in Answering Questions

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Question and answer (Q&A) sites can capture a range of user perspectives on using complex, feature-rich software. Little is known, however, on who is contributing to the sites. We look at contribution diversity from the perspective of gender in a domain with near gender parity: graphic design. Through content analysis of 330 answers from two popular Q&A sites and semi-structured interviews with 24 graphic designers, we examine who is contributing, what content, how the community shows appreciation towards their answers, and perceived motivations and barriers to participation. We find that despite gender balance in the field, women contribute far less frequently than men. We also see gender differences in contribution styles and user appreciation. Our interviews shed further light on how Q&A community cultures might be impacting men and women differently and how design choices made by the sites' developers might be exacerbating these differences. We suggest implications for design for improving gender inclusivity.

CCS Concepts: • **Human-centered computing → Collaborative and social computing**

KEYWORDS: Stack Exchange, Quora, Q&A sites, gender, women

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1 INTRODUCTION

Online communities are the go-to resource for troubleshooting complex feature-rich software (e.g. graphic design software, 3D modelling applications, statistical analysis packages). These

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communities offer rich learning materials, such as offering guidance for accomplishing a task with screenshots and videos, tips on adapting workflows to different software versions, and sometimes even provide resources tailored for users with unique application needs and skill levels. As such, these learning materials have become a predominant resource for feature-rich software users [25]. Importantly, online communities can offer benefits, not only to the content consumers, but also to the content creators. For creators, in addition to the intrinsic rewards of helping other community members, participation is an opportunity to showcase their skills [80,112] and can open informal networking opportunities that can be useful for advancing one's career, especially as recruiters look at these communities to find experts to hire [27,90,117,118].

Given the benefits of these online feature-rich software communities, it is not surprising that designing and evaluating how well they support users in sharing their feature-rich application knowledge is an active area of research (e.g. [8,15,64]). What is surprising, however, is how little we know of the characteristics of those who are currently contributing their knowledge online. Focusing specifically on gender, the extent to which current communities are appealing to both men and women is an open question. In addition to the potential career benefits outlined above that make gender-balanced participation important, prior work in other domains has shown that when community contributions suffer from gender imbalance, the resulting content can be more tailored to the interests and objectives of the majority group (e.g. [19,85]). For example, there are more men contributing to Wikipedia than women [3,57], with indications that this can lead to more articles focusing on men and their own accomplishments, whereas articles about women often focus on their relationships [106].

In light of the above, if women and men are not participating equally in knowledge-sharing for using feature-rich software, the materials produced might be less diverse than they could be, and it could also be an indicator that some people in the field are missing out on important networking and career advancement opportunities. Prior work provides compelling evidence that studying the unique experiences of both men and women with respect to their interactions with technology can produce insights that ultimately contribute to more inclusive designs [9,38,105]. But, are men and women sharing the feature-rich software knowledge online to the same extent? As a first step to answering this larger research question, we focus on gender differences in question and answer sites (Q&As) for graphic design software. Gender differences in online participation have been studied in several online communities, with prior work revealing key differences and nuances, often unique to the type of community (e.g. [19,30]). This prior work, however, has often focused on gender impacts of technical contributions in fields where men are the majority (e.g. [30,65]) and of non-technical contributions were gender ratios are balanced (e.g. [69,107]). Our investigation of Q&As for graphic design software is different in two important ways. First, feature-rich software is a cornerstone of graphic design, and knowledge in this field comes in various forms, from technical software tips, to ways to achieve creative outputs, to opinions on different workflows [14,49,54]. Second, the graphic design field has a relatively balanced number of men and women [92], which could lend itself to more balanced participation rates in comparison to other domains like programming [102], where men far outnumber women in the field [92]. (There is evidence that people in gender minority situations participate differently than when they are in the majority group [17,100,110].) In studying Q&As for graphic design software, we thus contribute new insights on gender differences in communities where the knowledge sharing has a both technical and non-technical components, and where men and women are at least present in the field in similar numbers.

To examine gender differences both within and across communities, we studied two Q&A sites with different dynamics and objectives used by graphic designers: Graphic Design Stack Exchange and Quora, with Photoshop as our target feature-rich application. In this first study, we treat gender as a binary construct, acknowledging its limitations in representing a full range of gender identities. A more comprehensive analysis of the spectrum of gender identity on sharing feature-rich application knowledge is an important area of future work.

To answer our research questions of how men and women are participating in Q&A platforms for graphic design, we employed a mixed-method approach. We began by analyzing a sample of existing contributions and conducted interviews with platform users. Our analysis of 330 posts across the two platforms indicates that contributions are dominated by men, but more so on Stack Exchange than on Quora. On Stack Exchange, we found that, relative to men, women tend to answer more opinion-oriented questions, receive less community appreciation, and show more confidence in their language usage. We find fewer such gender differences on Quora, a community that encourages multiple perspectives and posts from identifiable contributors [82]. Additionally, on Quora, we find that women are far more likely to respond to older questions. Our interviews with 24 users of these sites provide additional insight on aspects of the two communities that might be appealing to men and women differently.

To summarize, our work contributes: i) a first study of gender differences in Q&A sites for graphic design software, showing gaps in participation by women; ii) a content analysis identifying gender differences in posted answers and community appreciation, and iii) interview findings, that when interpreted using prior gender research, suggest key platform design and community elements that might be leading to these differences.

2 RELATED WORK

Q&A sites are one of many ways people share feature-rich software knowledge. Prior research has studied community-generated knowledge shared as external tutorials (e.g. [35,80]), as comments to tutorials (e.g. [8,23,53]), as in-software help content (e.g. [15,63]), as command recommendations (e.g. [55,64]), and recently as creative livestreams [32]. In many cases, however, the emphasis has been on creating novel prototypes and evaluating content they elicit. Consequently, there is limited insight on who is sharing their software knowledge online, particularly from the perspective of gender diversity.

To situate our study within the literature and to contextualize our findings, we overview two primary bodies of prior work: studies of gender differences in online communities and general motivations to contribute to online Q&A sites.

2.1 Gender Differences in Online Participation

Recent work on gendered participation in online communities has revealed nuanced findings, which collectively suggest that how men and women contribute differs according to the nature of the community and domain of knowledge (e.g. [57,69,77,85,102]). Given that graphic design Q&A communities (e.g. Stack Exchange and Quora) are both meant to be knowledge bases and social Q&As, we overview prior work that has studied gender differences in online communities filling either or both of these roles.

Wikipedia is a well-known open encyclopedia reflecting the perspectives and knowledge of its contributors and has thus received much attention from gender researchers. However, research has found that both its contributors and its knowledge content have issues when it comes to gender balance. It has been shown that fewer women make edits to articles than men

[3,57], but that the women who do contribute tend to make longer revisions. Prior work has suggested a number of factors that could be contributing to these differences in participation. Hargittai and Shaw have found that one's internet skills (which they have measured by years of internet usage, autonomy of usage and frequency of usage) is a strong predictor of level of contribution on Wikipedia, where more skilled individuals are likelier to contribute; yet, on average, women have lower such internet skills [39]. Menking and Erickson describe how women Wikipedians have to engage in emotional labour to participate in Wikipedia's environment [67], and Menking, Erickson and Pratt describe how women have to develop techniques to navigate and edit Wikipedia safely [68], efforts that some might find unappealing to become contributors.

Research has found that what knowledge content is shared also has a gender bias. When comparing Wikipedia and Encyclopaedia Britannica, Reagle and Rhue found that although coverage of articles about men and women on Encyclopaedia Britannica is unbalanced, it is even more so on Wikipedia [85]. In direct contrast to these findings are Wagner et al.'s results, where they found that, on Wikipedia, women are potentially overrepresented compared to men in number of articles [106]. As the latter research is more recent, it could be possible that efforts to address this gender gap have been succeeding and that we should continue our efforts of building inclusive communities. However, Wagner et al. have also found that articles about women emphasize that they are women and tend to focus on their relationships with men, but not vice-versa [106]. To emphasize that this is not just a problem with Wikipedia, research has found similar results in another open knowledge base, OpenStreetMap. More men contribute to the database [94], and on average, somewhat in contrast to the Wikipedia imbalance, men contribute knowledge about feminized spaces more frequently than women and vice-versa [19]. Therefore, given the fewer women contributors overall, there is less knowledge shared about masculinized spaces. These two examples illustrate how gender imbalances in the community impacts what knowledge is being shared.

In socially oriented sites, such as blogging and discussion groups, findings are mixed. Although no gender-specific preferences for methods of online communication and relationship building have been found [99], there are platform- and domain-based differences affecting men and women's objectives and levels of engagement. In blogging, women tend to favour the social aspects and use the activity as a creative outlet, men are more interested in opinions and information, while both see blogging as a leisure activity and find similar levels of satisfaction [77]. When video blogging, women create more blogs about personal matters, whereas men focus more on blogs about entertainment, public issues and technologies [69]. Women interact more with other bloggers, for example by asking for topics that they should cover in their own blogs, than do men [69]. Conversely, in online travel communities, women attach more importance to entertainment and enjoyment [107]. In cancer communities, women post more frequently than men, and in particular, share more messages about emotional support, while men are likelier to answer questions [34].

Q&A sites, the focus of our work, have both encyclopedic and social elements. An analysis of Yahoo! Answer has found that answers using neutral language tend to be preferred over others, and that, on average, women use more positive language in their answers while men use neutral language [51]. Otherwise, to our knowledge, most gender research on Q&A sites has focused on the programming site, Stack Overflow, with the aim of understanding the effect of participation in a field in which women are underrepresented [92]. Vasilescu et al. have found that most of Stack Overflow contributors are men, and that they participate more frequently,

earn more reputation and appear more willing to "play the game" to increase their reputation than women [65,102]. Research has explored reasons why this might be the case. According to a survey and interviews, women rated their lack of awareness of site features, their low self-confidence, discomfort with the community and the perception that participation was seen as slacking as higher barriers than men did, although other barriers, such as fear of negative feedback and time constraints, were highly rated as obstacles by both groups [30]. Research also suggests, however, that women are likelier to engage if they encounter other women sooner in their interactions with the community [29]. As women are a minority in programming, it is important to also explore Q&A participation in fields with more gender balance, such as graphic design. We also emphasize that graphic design has broader types of knowledge than programming; whereas programming is very technical, graphic design has a mix of technical and non-technical knowledge.

To summarize, prior work has found that men and women have differences in rates and types of participation, but that these differences vary between and within types of communities and over time. This emphasizes the need to study gender differences in more fields, and as they develop. We extend this work by studying the gender gap in graphic designers using Q&A sites to share feature-rich software knowledge – a field with similar numbers of men and women using platforms for technical knowledge and opinions. Like all of the work referenced above, we also begin by examining contributions from a binary perspective of men and women.

2.2 Motivations and Obstacles for Participating on Q&A Sites

General motivations to share information on different platforms (e.g. Q&A sites, online discussion forums, product/service review sites), or lack thereof, has received much attention in prior work. Research has identified a number of motivation aspects, involving both intrinsic and extrinsic motivation [60,73,83]. Intrinsic motivation leads to altruism, learning opportunities and claiming personal ownership, while extrinsic motivation focuses on raising one's status, accessing restricted information, and receiving financial rewards [42,62]. Informed by this previous research, Sun et al.'s model identifies four aspects affecting a person's willingness to contribute online with associated obstacles [95]: community factors [50,74], individual factors [74,88,98], commitment factors [72,84], and site quality factors [22,74]. Although research on motivating factors for participating in online (or offline) communities spans many domains, we focus on the work studying online Q&A sites.

To encourage quality contributions from users, reward and reputation mechanisms exist on many Q&A sites, such as Stack Exchange, Quora, and Yahoo! Answers. These features have been described as crucial for motivating knowledge sharing behaviour [43], but research of Q&A sites adopting such systems have found that it is not that simple. For Q&A site users, their reputation on its own is not as important as their rank relative to other users [111] and they will try to earn as much reputation as possible in a day to compete [62]. In addition, receiving thanks from a question asker is not very motivating, unless it affects some sort of leaderboard [48].

Other studies of Q&A sites have taken a more nuanced perspective. It has been found that motivations can evolve over time, especially as users may transition into different roles in the community [33]. Research shows, for example, that gamified elements, such as badges, can help stimulate initial participation [11], but that enjoyment of helping others is a strong motivator once it is experienced (i.e. only after a user starts actively participating) [26]. Similarly, users with higher levels of expertise [96], and even professionals [115], answer simply to help others,

even though they might have less time to answer questions [73], whereas other users have stronger extrinsic motivations, such as improving their reputation and expecting reciprocity [115]. This is supported by work done outside of Q&A sites, which found active and expert users simply enjoy helping others, and that others had expectations from the community in return when they participate [56,109].

The relationship of extrinsic and intrinsic motivations for participation on Q&A sites has also been studied. Extrinsic rewards, such as receiving virtual rewards, undermine intrinsic motivations, such as enjoying helping others [116]. For example, adding market exchanges to Q&A (i.e. the question asker must pay for answers) negatively affects community attachment to the site [42], with similar observations outside of Q&A sites as well [2]. Even when non-monetary rewards are offered, such as advertising extra reputation points for the best answer, questions get fewer answers, although the asker's chosen "best answer" is posted sooner [16].

Obstacles to participating on Q&A sites have also been studied. As one might expect, if a user does not know the answer to a question, they are less likely to participate [20,109]. Active users of Yahoo! Answers sometimes choose not to answer questions out of concern of how the question asker will react, how their answer will lose meaning if too many other answers are posted, in addition to the simple fact that they are not familiar with the question topic [20]. The length of the question also seems to affect how many answers it will get; on an academic Q&A, long questions lead to fewer answers [21], while on a generic Q&A, the opposite was found [59]. Privacy concerns also affect users' behaviours, where increased anonymity might be more appealing and encourage higher-quality contributions and increased user retention [4,45]. We add to this research by looking at the impact of gender on obstacles to contributing to graphic design Q&A sites.

In summary, we see that community reward mechanisms, meant to encourage participation, may not have their intended effects in all cases and that there are many factors affecting motivations to contribute knowledge to Q&A sites. We add to this body of research by providing insight into motivations and obstacles from both men and women in the domain of graphic-design software.

3 CONTENT ANALYSIS OF POSTS ON STACK EXCHANGE AND QUORA

We started our investigation by analyzing content posted to two Q&A sites used by graphic designers: Graphic Design Stack Exchange and Quora. Our research questions centered on the extent to which the content posted by users, and its treatment by the community varies by gender and community. We analyzed the content of answers according to various characteristics, such as length, linguistics and type of content; and how the community showed appreciation for the answers by looking at their scores and their authors' reputations.

We focused our analysis on content related to Adobe Photoshop, a feature-rich application that is frequently used by graphic designers and is regularly used in the literature as a canonical feature-rich application (e.g. [8,13,24,31,47]). Due to Photoshop's complexity, there is the potential for questions that elicit a range of answers, including both technical and opinion-related (e.g. perspectives on different workflows).

Before describing our sampling method, analysis and findings, we begin by describing each platform.

3.1 Stack Exchange and Quora: Website Characteristics

For comparison purposes, our study involves two sites: Quora (Figure 1) and Graphic Design

Stack Exchange (SE) (Figure 2). In this section, we describe some of their key characteristics.

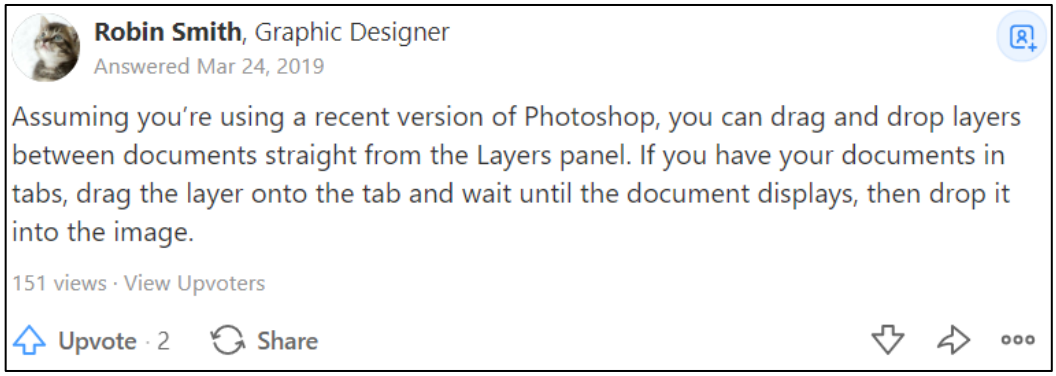

Figure 1: Screenshot of an answer on Quora. The answer author with their qualifications are at the top (anonymized by paper authors), followed by the answer content, and then the buttons for voting and sharing. The answer's score is displayed beside the upvote button (2 in this case). The downvote button is on the right side.

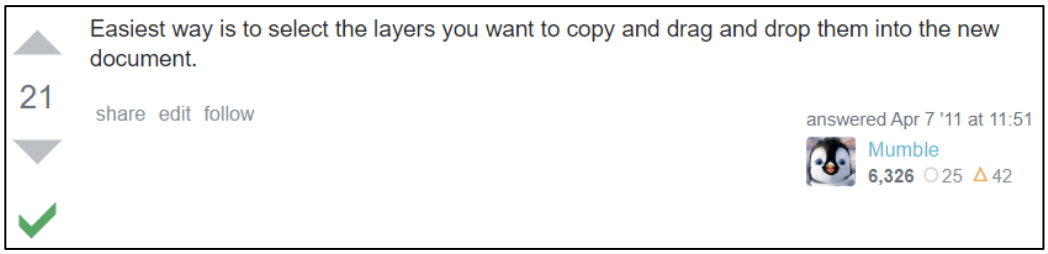

Figure 2: Screenshot of an answer on Stack Exchange. The answer content is in the center, the answer's score (21 in this case), voting buttons, and a green checkmark indicating it is the accepted answer are to the left, and the author is in the bottom right corner (anonymized by paper authors). Below the author's name is their reputation score (6,326) and the number of badges earned (25 silver badges, 42 bronze badges).

Quora is a general-purpose Q&A site; every subject potentially has a *topic* of questions available. A user will see content from topics to which they subscribe. Unfortunately, at the time of writing, official statistics for gender distributions were not available, but it is thought that, overall, more men than women are active on Quora, with gender ratios varying by topic [81]. For our study, we focus on topics related to graphic design.

On the other hand, Graphic Design Stack Exchange is but one website (called exchanges) under the Stack Exchange umbrella. A user must register to each individual exchange. While no statistics are available for Graphic Design Stack Exchange, the gender ratio on Stack Overflow, the original and most popular exchange, is heavily dominated by posts from men [91]. It is important to keep in mind, however, that Stack Overflow is exclusively for programming questions, a field with mostly men [92].

As Q&A sites, both Quora and SE are composed of questions and answers. To show appreciation towards content, users can vote on answers: upvotes increase an answer's score, while downvotes decrease it. SE additionally allows question askers to pick one *accepted answer* (the green check mark on the left-hand side in Figure 2). Answer order on SE is the accepted answer first, then in decreasing order by answer score, which is prominently displayed next to each answer (on the left-hand side of Figure 2, 21 in this case). On Quora, answer score is

deemphasized (the bottom left of Figure 1, 2 in this case) and is but one aspect that is considered in their "black-box" algorithm for sorting answers. Furthermore, on SE, answer scores affect the answerer's reputation score (along with earned badges and other activities)(shown in the bottom right of Figure 2), which determine privileges to the site (such as posting abilities, access to moderation tools, and access to site analytics). Quora does not have a reputation feature.

One of Quora's rules is that users must use their real name. Although based on the honour system, other users can report those with names they believe to be false. Answers include the poster's name, and optionally, a line on their qualifications (top of Figure 1, Robin Smith, Graphic Designer in this case). Conversely, SE users can use any username they want. Some use their complete real names, some a nickname, others maintain a default username of the form *user12345*. SE does not have a line about qualifications like Quora, however, users' reputations are displayed next to their username (bottom right of Figure 2, Mumble with a reputation score of 6,326 in this case). On both sites, users have the option of adding links on their profiles to their accounts on other platforms.

3.2 Method Overview

We collected approximately 200 answers from Quora and SE each, as we describe in the Sampling Answers section. With each answer, we collected its score, content and post time, with the author's name, location and profile URL. For SE answers, we also noted whether it is an accepted answer, and the poster's reputation.

Using the author's name and information available in their profile, we attempted to resolve the author as presenting themselves as either a man or a woman, although not every user's gender was identifiable with the available information. We describe our gender resolution approach in the Resolving Genders subsection.

We analyzed the answers qualitatively and quantitatively for any gender differences. We describe our analysis procedures in the Data Analysis and Results subsections.

3.3 Sampling Answers from Quora and Stack Exchange

Our goal was to collect a sufficient amount of Q&A posts by men and women on Quora and SE. In collecting questions and their answers, we followed these criteria: (1) The questions had to be about using Photoshop. (2) After observing that many questions with fewer than two answers were difficult or poorly phrased, the questions had to have at least two answers to control for quality. (3) We would collect the complete set of answers from each question. We aimed for approximately 200 answers per platform to enable strong signals to emerge from the data, while still being a feasible sample to collect and code manually.

To collect answers from SE, we used the Data Explorer tool [89], which takes queries and outputs content from the SE network. As SE's community and interface have evolved over time, we aimed to collect recent posts, so we filtered the output to include posts between June 24th, 2017 and July 6th, 2018. To satisfy the first and second criteria, we filtered for questions that had the *adobe-photoshop* tag and which had more than one answer. The questions were then randomly ordered to remove any sorting bias by the querying tool. The tool returned 353 questions satisfying our query. We collected all the answers posted to these questions.

Since Quora does not have a similar tool, we collected questions manually. We opened the *Adobe Photoshop* topic and saved all of the questions that our browser would load (532 questions). We randomly ordered the questions, to reduce bias from the default sorting method. We then manually opened the questions' pages, adding those that satisfied our criteria to our dataset.

Although we filtered using the adobe-photoshop tag (SE)/Adobe Photoshop topic (Quora), some questions were either misclassified or were not about learning/using software (e.g. how to obtain Photoshop). To focus on feature-rich software knowledge sharing, we further ensured that the sample of questions related to any of the following: Photoshop commands, the feasibility of an idea, requesting examples of sample output, or how to obtain a particular effect. From the initial set of 885 Quora and SE questions satisfying criteria 1 and 2, we collected answers until we had at least 200 answers per platform. By satisfying criterion 3, we ended up with 203 answers from 80 SE questions, and 202 answers from 32 Quora questions.

We then resolved the authors' genders for the answers (see the Resolving Genders subsection). Following this sampling method, we found that only 9 answers (4%) on SE were by women, compared to 126 by men (63%), while Quora had 38 (19%) and 156 (77%) respectively. Although this might be representative of the distribution of men and women, the 9 answers by women on SE is an extremely small set to analyze and is too sparse for statistical tests. Therefore, for the SE data, we instead use all questions from our original set of 353 questions that had at least one woman answering it, while randomly selecting other questions that fit our criteria to reach at least 200 answers. This means that this sample is no longer representative of the distribution of men and women contributors, however comparisons between answers from men and women are still valid. For the following analyses, we use this set of answers, which has 27 (13%) posts by women, and 121 (57%) posts by men. The gender distributions are illustrated in Figure 3.

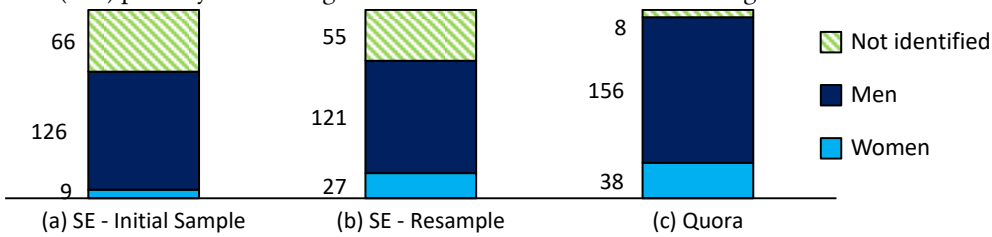

Figure 3: The distribution of sampled answers by gender. The purpose of (b) was to include more posts from women for analysis; (b) and (c) are the main data points used in the analysis.

For brevity, we exclude answers that did not resolve as from a man or woman in our reporting of the results (so numbers will not sum to 100%). Our analysis of posts by authors whose gender we were not able to resolve suggested that this data tended to fall in between the results for men and women. Our remaining analyses include 148 answers by 71 unique users from SE and 194 answers by 167 unique users from Quora. Most of the contributors in our sample posted only a single answer, with a median number of answers of 1 for both men and women on Quora (IQR = 0) and SE (IQR = 1).

3.4 Resolving Genders of Contributors

In our main data sample (Figure 3 (b) and (c)), we coded gender manually as follows. Two researchers (one Canadian man, one Iranian woman) independently coded all the answer authors as presenting themselves as a man or as a woman, or as not presenting any gender-identifying information (not identified). Our coding considered a combination of the following: gender identification in profile (e.g. pronouns, gendered role such as "father"), gender identification in linked accounts, gender identification in posted questions or answers, name (if a real name was used) and profile picture. According to Cohen's kappa, there was high agreement between the two researchers for SE ($\kappa = 0.823$, $p < 0.001$, 95% CI, 0.727 to 0.919) and Quora ($\kappa = 0.845$, $p < 0.001$, 95%

CI, 0.741 to 0.949) users' genders. The researchers then discussed cases where disagreement occurred until they reached consensus on the final code (Man, Woman or Not Identified).

For the initial SE dataset with few women (Figure 3 (a)), and an additional dataset used to generalize one of our findings (response speed), described in our Results, we leveraged a tool used in prior work on gender differences in online communities to minimize our manual work: Vasilescu et al.'s 2012 Gender Computer [102]. The tool uses a name-based approach, similar to other studies using existing posts by online community members [40,52,103], and is generally found to be more accurate than other automated alternatives [102]. The tool compares author names to name lists from 33 international regions (e.g. censuses) and assigns gender when the name is twice as likely to be one gender than the other. For the names left undefined by Gender Computer, we manually resolved as many as we could using the above described method.

Vasilescu et al. report an accuracy of 90% in gender recognition [102]. When comparing the tool's results to our entirely manual approach using Cohen's kappa, we obtained substantial agreement for both SE ($\kappa = 0.687$, $p < 0.001$, 95% CI, 0.55 to 0.824) and Quora ($\kappa = 0.757$, $p < 0.001$, 95% CI, 0.649 to 0.865). Considering resource constraints in identifying genders in such a large dataset, we consider Gender Computer to be a reasonable tool for our additional analyses.

We acknowledge that our data will not speak to the contributions of those whose gender we could not resolve. We also emphasize our gender resolution method is based on how users present themselves, so those who do not use their name, or use a gender-neutral name (without any additional identifying information) may not be accurately resolved.

3.5 Data Analysis

We analyzed answers quantitatively and qualitatively. For the quantitative analyses, we used Mann-Whitney tests to compare medians and Pearson's chi-squared tests to compare categorical distributions. We report results as significant if $p < 0.05$ and as potential trends if $p < 0.1$. To determine question types, the lead author coded the questions over many iterations, with an additional author going over the codes and samples of the raw data after every iteration. Two other authors would give feedback on the codes to ensure they were understandable. We used the Linguistic Inquiry and Word Count 2015 tool [78] for linguistic analyses. The medians and inter-quartile ranges are in Table 1.

Table 1: Summary of the content analysis. Statistically significant results are bolded and italicized. Potential trends are italicized.

		Graphic Design Stack Exchange			**Quora**		
		Men's Mdns (IQR)	Women's Mdns (IQR)	*p*-value	Men's Mdns (IQR)	Women's Mdns (IQR)	*p*-value
Answer Characteristics	Answer Length	83 words (80)	86 words (117.5)	0.907	57.5 words (81.5)	60 words (90.5)	0.646
	Response Speed	2.9 hours (15.2)	3.2 hours (17.5)	0.851	***16.9 hours (114.5)***	***744.6 hours (3763.8)***	***< 0.001****
	Clout	***50 (25.9)***	***61.8 (13.5)***	***0.021****	58.7 (28.8)	66.3 (36)	0.296
	Emotional Tone	49.3 (47.1)	62.1 (50.9)	0.365	62.1 (65.7)	74.6 (65.9)	0.272
	Analytical Thinking	89.5 (15.7)	89.7 (20.8)	0.217	76.2 (40.7)	82.3 (42.2)	0.988
Community Appreciation	User Reputation	***13184 (24961)***	***96 (4247)***	***< 0.001****	- N/A -	- N/A -	- N/A -
	Score of Answers	*1 (2)*	*1 (1.5)*	*0.051**	1 (2)	1 (3.75)	0.176
	Accepted Answer	23.1%	11.1%	0.200	- N/A -	- N/A -	- N/A -

3.6 Results

In this section, we examine differences in contributions by men and women both within and across platforms. We begin by comparing the nature of the answers by men and women. We follow this with gender differences in which answers and users receive community appreciation.

3.6.1 Type of Knowledge Contributed

To contextualize our analyses, we start with the type of questions answered in our sample and any gender differences in responses to particular question types.

Our open coding identified four question types: looking for a factual answer (e.g. yes/no answer, location of a command, troubleshooting software), asking for opinions (e.g. other users' preferred technique), requesting examples (e.g. of output or of common tasks using a tool) and asking for workflow or technique information (e.g. how to accomplish a task). Examples of each can be found in Table 2.

Table 2: The question types with definitions and examples.

Question Type	Type Definition	Example Questions from Quora and SE
Factual	Question has a factual, definitive answer	What blending mode is this?
Opinion	Asks for users' preferred techniques or tools	Which is the best tool for a clipping path in Photoshop?
Example	Requests for example output or example command usages	Can you show me your Photoshop-edited photos?
Technique	Describes how to accomplish a task	How can I bright up a picture through Photoshop?

When looking at the distributions of men and women's answers according to question type, the results suggest a potential trend for SE's question types (SE: $\chi^2 = 4.879$, $p = 0.073$, Quora: $\chi^2 = 2.417$, $p = 0.517$). On SE, women appeared to answer more questions asking for opinions than expected, as opposed to factual-type questions, and vice-versa for men. We also see that the distributions of question types across SE and Quora are quite different. On SE, answers center around questions with a factual answer or asking for techniques. On Quora, the community with higher representation from women, the majority of answers offer opinions, closely followed by techniques. Only Quora included answers providing examples. Figure 4 illustrates these distributions.

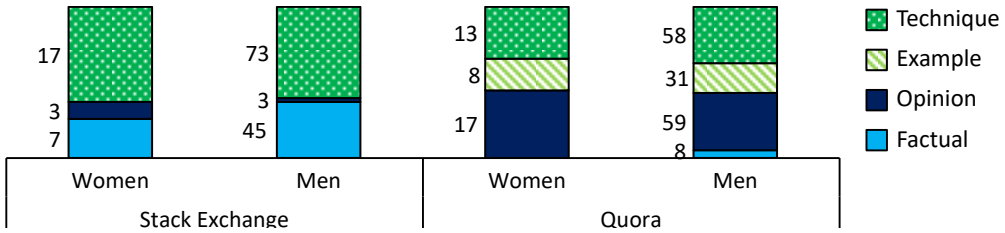

Figure 4: The distributions of sampled answers by which question type they address.

3.6.2 Characteristics of the Answers

We then looked at gender differences in the content of the answers, including answer lengths, the speed at which they were posted (relative to the question), and their linguistic properties.

Answer Length

We examined differences in answer length by comparing word counts. On SE, men and women had answers of about the same length (Mdn 83 vs. 86). This difference was not found to be statistically significant (U = 1609.5, z = -0.119, p = 0.907, r = -0.01). On Quora, men and women also had answers of similar lengths at 57.5 and 60 words respectively, a difference not found to be statistically significant (U = 2820.5, z = -0.462, p = 0.646, r = -0.033).

Response Speed

Motivated by prior findings on fast response times on SE [62], we looked for gender differences in response speed. On SE, men and women posted responses at about a similar time lag, with no statistically significant difference (U = 1595, z = -0.191, p = 0.851, r = -0.016). On the other hand, women posted far later than men on Quora. This difference was both large, with women's median lag time being 40 times that of men, and statistically significant (U = 1329, z = -4.623, p < 0.001, r = -0.342).

Considering the large difference on Quora, we explored the data further. First, we looked at which types of questions tend to elicit later responses. We found that the median response time for opinion-type questions (60 hours) was higher than for the other question types (technique: 31 hours, factual: 3 hours, example: 36 hours). We also observed that, regardless of question type, all but two questions that received a much later answer (e.g. > 100 hours after being posted), had received at least one reasonable answer within the first day.

Given the large variability in the time lag from women on Quora as well as the difference from the data of SE's women, we resampled Quora answers to see if the result happened to be unique to particular data points in our data. We resampled 106 answers using our previously described method (to check only response speed). After pre-processing, we analyzed 19 answers from women and 81 from men (a similar ratio to our main sample). With this second dataset, men (Mdn 11.18 hours, IQR = 71.22) still posted sooner than women (Mdn 31.90 hours, IQR = 6224.33). While the difference in medians is not nearly as dramatic in this second data set (3x vs. 40x), the difference continued to be statistically significant (U = 534.0, z = -2.069, p = 0.038, r = -0.207).

Linguistic Analysis

Using the Linguistic Inquiry and Word Count 2015 tool [78], we looked for gender differences in three linguistic summary variables that we felt had the potential to be relevant to this type of content: clout, emotional tone, and analytical thinking. This linguistic tool has been developed over the course of decades of research, with each summary variable having undergone peer review [79]. It is a standard tool used by the HCI community, although its original purpose was for diary and reflexive writing analysis.

Clout refers to the level of confidence exhibited in the text. A high score in clout describes confident, seemingly high-expertise text, while low clout describes a humble style. On SE, women expressed higher clout in their answer text than did the men, a difference that was statistically significant (U = 1170.5, z = -2.299, p = 0.021, r = -0.189). On Quora, the difference in clout score for men and women was not statistically significant (U = 2640, z = -1.047, p = 0.297, r = -0.075).

The tool characterizes the emotional tone of a text as ranging from negative (at 0), to positive (at 100). On SE, answers from men had a more negative tone than did the women's answers. This difference did not reach significance (U = 1450.5, z = -0.912, p = 0.365, r = -0.075). On

Quora, men, on average, again had a more negative tone than did the women, but the difference was not significant (U = 2624, z = -1.102, p = 0.272, r = -0.079).

A higher analytical thinking score means that the text has formal, logical or hierarchical properties, while a low score represents informal or narrative styles. Men and women displayed similar levels of analytical thinking on SE, with a difference not found to be statistically significant (U = 1384, z = -1.239, p = 0.217, r = -0.102). The difference was also not statistically significant on Quora (U = 2959, z = -0.016, p = 0.988, r = -0.001).

3.6.3 Which Answers Receive Community Appreciation?

We next turn to gender differences in answers being appreciated by the communities. We looked at three dimensions of appreciation: users' overall reputation scores, the score of answers, and which answers are chosen as accepted answers.

User Reputation

On SE, users earn reputation points through their answer scores (see above) and badges earned through community activities such as posting comments, receiving a certain number of upvotes, etc. Here we compare reputation scores for all users who have answers in our dataset. Men's reputations were higher than women's reputations (Mdn 121 vs. 27), a difference found to be statistically significant (U = 698.5, z = -4.652, p < 0.001, r = -0.382). Quora does not calculate a summary reputation score for its users.

Score of Answers

Users can give upvotes and downvotes to answers, the sum of which are answers' total scores. Men on SE received higher scores than women, a difference that did not reach statistically significance but suggests a trend (U = 1254, z = -1.951, p = 0.051, r = -0.16). Conversely, on Quora, Table 1 shows that both men and women had similar scores (U = 2564, z = -1.357, p = 0.176, r = -0.097). However, with women's scores having a greater spread than men's scores, we do not discount the possibility of a significant difference given more data.

Accepted Answers

SE encourages question askers to pick one "best" answer. In our SE sample, 23.1% of men's answers were accepted answers, while only 11.1% of women's answers were selected. This difference, however, is not statistically significant (χ^2 = 1.929, p = 0.2). This form of community appreciation does not exist on Quora.

3.6.4 Content Analysis: Summary

The above analysis highlights some key gender differences both within and across platforms. Both platforms appear to be skewed towards contributions from men, despite gender balance in the graphic design field. The participation of women, however, is over four times higher on Quora than on SE (4% in our original SE sample vs 19% on Quora). Women seem to answer more opinion-oriented questions on SE than men do, and, overall, Quora elicits more opinion-oriented knowledge than SE. Linguistic analysis indicates that on SE women's answers expressed more clout than men's answers. On Quora, we saw that women were far more likely to respond to old questions than men, sometimes dramatically so. In terms of community appreciation, men on SE generally have a higher degree of recognition than women.

4 SEMI-STRUCTURED INTERVIEW STUDY

To shed light on some of the patterns in our content analysis, we conducted semi-structured interviews with 24 graphic designers who have used SE and/or Quora. Our goals were to understand perceptions of the communities with the aim of contextualizing some of our observed gender differences across the two platforms. We also sought perspectives on barriers and motivations to contributing.

4.1 Participants

We recruited 24 graphic designers through word-of-mouth, advertising on a university campus, social media websites (e.g. reddit), and directly on Quora. We included only participants who had used Quora and/or SE for graphic design help, either as contributors or only as readers.

Eleven participants were women, while 13 were men. All participants had professional experience doing graphic design or were training to work in the field. Although only 11 participants were active contributors to these sites, everyone reported relying on Quora and/or SE as one of their sources for online graphic design help. Table 3 lists details about participants.

Table 3: Interview participants' characteristics. The Quora and SE, and Question and Answer columns are not mutually exclusive.

	Gender	Platform Used			Content Submitted				Graphic Design Expertise Level		
	Total	Quora	SE	Both	Question	Answer	Both	Neither	Advanced	Intermediate	Beginner
Women	11	9	7	5	4	3	1	5	5	5	1
Men	13	13	7	7	4	5	4	8	4	7	2
Total	24	22	14	12	8	8	5	13	9	12	4

4.2 Method

In the semi-structured interviews, we started by asking participants to state their gender identity, and to describe their graphic design and software experience. We then asked about their Quora and/or SE activities. If participants had posted, we asked about their motivations, and if they had not, about obstacles to participating. We asked them to explain what makes Quora and/or SE unique, and if they used both sites, to compare them. We ended with a discussion of how they determine the quality of answers. We were interested in gender differences that would emerge naturally through our discussions, so we did not ask specifically about the differences revealed in our content analyses.

The interviews lasted 45-60 minutes. Seven participants recruited locally were interviewed in person, while the 17 others were interviewed over teleconferencing software. One participant (M16) preferred a text chat interview.

All interviews were fully transcribed, and participants could request to review their transcripts. During analysis, we removed gender information from participants' quotes to reduce our own bias. The lead author first used open coding to get an initial sense of the data. Then, with one other author, collaboratively and iteratively developed an initial set of themes from the transcripts and codes, grouping quotes about similar topics or feelings [66]. Themes were further discussed, reinterpreted and revised by four of the authors during multiple joint meetings. The lead author then categorized the themes as containing either quotes from men, women or both (the gender information now being reintegrated with the quotes), and as either about Quora, SE or both. With themes identified from our own data, we then used previous

work to guide further refinement of the findings.

We looked for indications of gender differences in the transcripts, however, we were also cognisant of the complexity of issues that might hinder clear patterns from emerging with this type of qualitative data (e.g. [18,108]).

4.3 Key Findings

Our interviews revealed various preferences and reasons why men and women who are graphic designers might participate on Quora and/or SE. The primary themes involve: the limited opportunities for different perceptions on SE, a stronger sense of community on Quora, and the demands of contributing. We also describe contradictions in answering old questions and thoughts on showing appreciation for content.

4.3.1 Limited Opportunities for Different Perspectives on SE

Participants who posted on the sites were largely motivated by reasons that are well-documented, including receiving recognition [7], feeling good about helping [113], reciprocity [95], and it being a quick way to receive help [62].

One motivation unique to graphic design software, however, was the desire for designers to share unique perspectives, even if it might not be the "best" solution:

> Even if [there is already an answer, if] I'm writing a post, I'll still continue with it, just in case [it is] a different idea. Because I mean, if everyone on the internet can read it and answer it, they might find something even better. [...] Isn't that the whole point of having the internet? The whole world gets to talk to each other and say, "well you could also do this thing." (F10)

While this participant advocated for discussions collectively furthering knowledge, not all participants felt that sharing their perspective was worth the effort, a point we revisit later.

Questions with definite answers generally do not leave much room for different perspectives. We found few answers to these types of questions on Quora, and indeed, participants found it easier to give opinions on that platform:

> While in Quora, it's more like, there's a lot of room for discussion and less room for practical answers. [...] If you're looking for maybe deep answers, and long discussions, then Quora is more suitable for this, but if you are looking for something straight to the point with your answer and move on, then probably Stack Exchange is a better place, it's easier to find answers there. (M2)
>
> [Low-quality answers take] time away from relevant answers [...] But then everyone has a right for an opinion so that's the purpose of Quora, so that it's a balance. (F9)

That participants felt it easier to share opinions on Quora, might partially explain some of the longer lag times that we observed. As our content analysis indicates, opinions appeared to account for more of the later posts, and women posted most of them. Together, this could imply that women feel welcome to share their opinions at any point in time on Quora, even if there are already answers. SE had mostly factual questions or questions about technique – once there is a correct answer, there is little incentive to post further.

4.3.2 Stronger Sense of Community on Quora

Previous work suggests that women prefer to engage with online communities more than men [69,77], and that women tend to acquire knowledge by socializing [12,97]. In our interviews,

women pointed out that there are obstacles to doing so, particularly on SE, while no men volunteered this as a barrier.

The biggest issue that came up was the anonymity of the other users on SE; there is no information about other users, making the website feel impersonal. In contrast, Quora enforces the use of real names.

> I [can] find out [what] this person [using their name] is doing professionally in Photoshop. Some [of the] ideas important to me, [like what] are [their] origins. [...] But the other ones that have anonymous nicknames, no. They're not important to me, you know? (F24)
>
> I'm talking to a person I don't know. [...] The Stack Exchange experience is very cut and dry. You know, it's just like, here's my question, here's some answers. People chime in, blah, blah, blah. [...] It feels a bit overwhelming to just have people sort of like throwing answers at you. I'd rather deal one on one. [...] (F27)

Although men also mentioned the issue of anonymity, they phrased it as a privacy concern rather than an obstacle to communication:

> [My] issue is when I make an account, after a while, I tend to forget about them. You know nowadays, they have a database or something, and [my information] gets stolen. (M5)

Prior research suggests that women are generally more concerned with their own privacy online (e.g. [28,41,114]); however, when it comes to knowledge sharing, men appear to be more concerned [12]. Our results seem to lend support for this distinction.

A further issue is the size of the community. Other women described Quora's community as very large. Although this has its benefits, such as being easier to reach many people for help, participants felt like this could be overwhelming, or that their mistakes would be noticed by a large audience.

> [It's] almost like you can hear a pin drop and you're like, um, in a minute you're gonna understand why no one's commenting on this if you just thought about it for a little bit longer. (F25)

Participants suggested that a potential solution would be to strengthen the barriers between local communities that form around Quora's topics. This follows the idea that women prefer to communicate in more private circles and that men have large social networks [5,6].

Overall, it appeared that the women considered Quora to be a more social community than SE:

> Quora is a little bit more social according to me. And if I'm getting information about graphic design, [...] it's like a social site. You can ask about anything. It's really interesting. But Stack Exchange is more professional, that's, my opinion. It seems more professional, it's a little less interesting. (F6)

Thus, while the size of Quora was daunting to some, social aspects seemed more important to the women in our sample than the men, with Quora providing the better social balance.

4.3.3 Too Demanding to Post, Probably in Vain

Many participants talked about the challenges of crafting answers, to the point that it was not worth their limited time. Prior research has found that women, on average, tend to have less

time than men due to carrying a larger percentage of the domestic work in addition to their professional duties [101]. Some men expressed the effort it took to be authoritative enough, while women felt that posting answers was not worth the effort. Below we elaborate on some of the time/effort-related obstacles to creating and posting answers expressed by both genders.

First, there is the expectation that posters carry authority in their answers. Participants mentioned that they did not feel that they could post if they did not have this authority:

> An answer should be authoritative. I don't think I have that. [...] An authoritative answer, in my opinion, [...] is completely factual, is full of facts, is correct. It cannot be disputed; there is no discrepancy or no errors in the answer. (M5)

This means that a sufficient amount of effort is necessary when posting adequate answers, including the effort of researching the problem and crafting sufficiently elaborate and justified responses:

> [Sometimes,] when I have written down an answer, or maybe 30% of the answer, I feel that this is going to take too much time, I have to back it up this way, I have to attach the source, or whatever. And I just feel it's not worth the effort, and I close it. (M21)

Interestingly, the importance of authority was more prevalently expressed among the men, with only a couple of women mentioning it in passing.

Even if participants went through the effort of posting questions and answers, unsurprisingly, most worried about receiving negative feedback in response. While both our men and women expressed concerns over negative feedback, at least one woman felt that the criticism was less severe on Quora:

> If you're going on Quora, you know that you can ask the dumber questions, and you won't really get put down with negative answers, or anything. So, I [feel] it's more comfortable for beginners. (F26)

We also see from our content analysis that the text in SE is more negative than on Quora, with prior work suggesting that criticism might be internalized more by women than it is by men [44,86,87]. This concern over negative feedback might also relate to the linguistic differences in clout that we see on SE, where the women who do post, i.e., who overcome this barrier, do so with more authoritative language than the men.

Overall, a few of the women, and one man, simply did not see enough benefit to answering questions, on either SE or Quora. The following quote indicates that current reward mechanisms were not sufficient for her to justify the effort:

> It just turns into a competition sometimes. It seems where it's kind of, like, this is internet points. None of this is real at all. (F25)

This sentiment from women is understandable, given our findings from the content analysis that women's posts were potentially not appreciated as much as men's.

4.3.4 Paradox of Stale Questions

In our content analysis, we saw that most answers were posted soon after the questions, except in the case of women's answers on Quora. In our interviews, without being prompted, many participants volunteered their thoughts on the age of the content they were reading or contributing to. However, they had contradictory feelings about this issue, and we did not observe any clear gender differences.

Participants agreed that recent answers tended to be more useful; any software features would likely be more up-to-date and more modern techniques would be shared.

> I kinda go by date, first. So, I see, I try to pick the one that's closest to current times. So, if I see one from 2013 versus one from 2018, I'll click on the one from 2018. (M12)

Even when they felt they could provide an up-to-date answer in light of new software versions and techniques, they felt the asker probably found their answer elsewhere.

> It never makes sense to me to answer an old question, from like a year ago. I just assume that they've already solved it, or they've already moved on from it. (F26)

Despite the benefits to updating answers, this also counters internet culture:

> It's called "necroing" a thread. And basically, it's an online courtesy of when at least, the longest you would comment on something is 6 months. So if [...] everybody solves it in the month of 2013, and then I come in 2016 or 2018 and I'm in the same thread and "hey guys have you solved this," that's considered to be real rude. [...] Especially if they solved the problem, [...] most of the people tend to look at you as an idiot. (M12)

Research shows that overall, men use the internet more frequently than women, and in such a pattern that potentially exposes them to this aspect of internet culture more often [76].

4.3.5 Community Appreciation of Content

Given the gender differences in community appreciation that we observed on SE, we asked participants to describe answers they would show appreciation towards. Almost all participants mentioned they would upvote answers that contain explanations, examples, screenshots, and are properly formatted. No participants, however, mentioned the posted guidelines as influencing their upvotes. Our participants also generally refused to give downvotes, unless the answer was truly inappropriate (e.g. was offensive). They explained that the poster at least made an effort to share knowledge, so did not want to discourage them:

> Maybe the answer doesn't have good elaboration or are not enough, but they are not bad, or they are not wrong, you know? So, I think just the wrong answers need a downvote. So, I just put upvotes. Because people need encouragement, not discouragement, actually. (F24)

Even though all participants had opinions on showing appreciation, no clear picture emerged that might explain the gender differences we observed in SE content appreciation. We elaborate on this in the discussion.

5 DISCUSSION AND FUTURE WORK

In studying the gender dynamics on existing socio-technical, collaborative websites such as Q&A communities, we provide the CSCW and HCI communities with ecologically valid insight into the extent to which these communities' design decisions and cultures are appealing to both women and men. Despite gender balance in the graphic design field and the potential for a range of contributions types (e.g. from technical to opinion-oriented posts), women were underrepresented in our content sample. With participation rates by women at 4% in our SE sample and 19% on Quora, this places the gender balance closer to those found in prior work on programming-centric Q&As [29,30,65,102] and encyclopedic platforms [3,39,57,67,68], than it does to, for example, blogging or online health communities [34,69,77]. This could suggest that feature-rich design

software are viewed primarily as technical entities, even though we see a number of non-technical contributions being made, particularly on Quora. Understanding how potential contributors conceptualize feature-rich software knowledge and how platforms might better convey its multi-dimensional nature is an interesting area of future research.

A key takeaway from our findings concerns the importance of considering different communities. Our sampling from two different Q&A communities illustrates how, even within the same domain, aspects of community norms and platform design can encourage or discourage gender-diverse contributions. Women participate more on Quora than on SE, and we also see fewer differences when comparing contributions from men and women on Quora. On SE, Women expressed more clout and had lower reputation scores, and potentially posted more opinions and had lower answer scores than men did on SE, while we saw none of these differences on Quora. On the other hand, women posted answers on older questions more frequently than men did on Quora, but not on SE. We also see that both men and women posted answers to different types of questions on Quora than they did on SE, namely, posted more opinion-based answers than factual ones. Interview participants also described how there are limited opportunities for different perspectives and a lower sense of community on SE, compared to Quora. SE might have inherited part of its reputation from the programmer-centric Stack Overflow with far more men than women [91], however, few of our interview participants were even aware of Stack Overflow.

Our interview findings, interpreted in light of other gender research (e.g. [5,12,97]), suggest that the differences across the two platforms are likely caused by a set of complex, interdependent factors. Like with any such complex phenomena, a collection of studies from the HCI research community will be needed to isolate different properties of the community and how they impact men and women differently, with our findings highlighting some particularly salient factors (e.g. reputation systems, community policies).

A second key takeaway from our findings is that women who are contributing are not getting as many benefits as men are from community appreciation and reputation systems on Stack Exchange. Our findings suggest that appreciation of content by women is lower in SE, with prior work suggesting that this criticism might be serving to drive away women [44,86,87]. Our study is not the first to identify gender issues with online community appreciation, particularly with respect to reputation systems [65,102]. Our findings, however, provide new insight into their scope, for example, by showing that they persist outside of programmer-centric communities to fields with greater gender balance.

Further study is needed to understand the root causes of the differences in community appreciation. For example, our findings revealed tonal differences. It could be that the community with higher representation of men is favouring patterns of expression that more closely align with their own (e.g. those with a more neutral tone). Appreciation could also be subject to conscious or unconscious bias. Prior work showing very strong evidence of gender biased assessments of teaching [61] and resumes [71], provide excellent starting points for further investigation.

We focused our efforts on graphic design Q&As with the assumption that a field with a similar number of men and women would lead to closer-to-equal levels of online participation. However, there are other factors affecting gender parity in a field, such as wages and leadership positions held. These could further impact online participation and unfortunately, graphic design could still be considered to be male-dominated along these other measures [1,37,46,93]. However, improving technologies and their communities of users have potential to empower women [70], furthering inclusivity and equitability. To this end, we propose some implications for design. We follow with a reflection on the limitations and potential generalizability of our work.

5.1 Implications for Design

Q&A communities, such as Stack Exchange and Quora, have taken different approaches when it comes to developing their platform features, policies and cultures. Our findings point to the need for continued innovation from the CSCW and HCI communities to establish guidelines (for design or otherwise) that will help communities encourage and support more equitable participation. We discuss some implications for design that are motivated by our findings.

5.1.1 Reconsidering Reputations Systems in Q&A forums

The results of our content analysis point out that women have lower reputation scores and potentially lower answer scores than men on SE. The research community has already begun to explore ways to address reputation imbalances on Q&A platforms. One approach is to adjust the scoring system, with recent work proposing an alternative scoring method that cuts the difference between men and women's reputation scores on Stack Overflow by half [65]. Our data suggests, however, the need to consider fundamentally different motivation/reward structures that appeal to both men and women. In our interviews, one woman outright volunteered that she was not motivated by a reputation score. A number of others indicated that they did not have the time to interact heavily with the site, meaning they would not be able to earn enough reputation to access all features. Even when looking at Quora's users' scores, we notice little difference between men and women's scores, and that they are in fact, quite low scores overall, suggesting that Quora's scoring mechanism is seen as a less important feature than SE's. Future work should consider alternative ways to highlight user contributions. For example, one could imagine summarizing the range of questions answered, or the degree to which answers have employed a positive or negative tone.

5.1.2 Emphasizing Opinions

Stack Exchange prioritizes short turn-around times for factual answers [62], and actively discourages answering questions soliciting opinions [36], yet we see women much more likely to provide answers to opinion-oriented questions, and to continue to respond to older questions (particularly in the case of those soliciting opinions). Policies such as encouraging factual, non-opinion-based answers are carried over from Stack Overflow; these might be suitable for programming-centric Q&A sites like Stack Overflow, but may not be appropriate for domains such as graphic design, where other types of knowledge, such as opinions, are also important. While further study is needed to determine why women are more likely than men to continue to respond to older questions, our data suggests that the emphasis on response speed and "correctness" might not be appealing equally to both genders. We speculate that a combination of factors is at play. For one, Quora regularly prioritizes older questions on users' feeds giving these questions increased community visibility. We have also seen that when older questions continue to receive answers, the discussion is starting to go beyond the initial factual answers, with newer answers focusing on opinions. From our content analysis, women appear to be more comfortable sharing opinion than men. Platforms that encourage this behaviour, emphasizing and rewarding answers that update old questions and that include opinions might encourage more contributions from women and lead to higher appreciation for those types of answers.

5.1.3 Emphasizing Social Elements

Previous work has found that women acquire knowledge by socializing [12,97] and in our interviews, more women than men expressed missing social elements, things as simple as real names and being able to relate to others, as a key barrier to contributing. While Q&A sites are not

necessarily meant to be social, the lack of social elements appears to be affecting women disproportionally; it is possible that women are simply using other help channels that are inherently more social, such as asking experts for help directly. Incorporating more prominent social features could help encourage women's participation online. Examples include more elaborate user profiles, personalized sub-communities, and real-time chat rooms. Both SE and Quora have social areas such as chat rooms, but they are not tightly integrated with the knowledge-sharing areas. Similarly, it has been found that SE users from collectivist cultures would benefit more from social elements than those from individualist cultures [75].

5.1.4 Lowering Contribution Barriers

Our results also suggest that lowering the time barrier for contribution might encourage more participation from women. In the area of feature-rich software, examples could be tools that support lightweight sharing from within an application [58], those that make it easier to share rich application context [63,104], or Q&A systems that are directly integrated within feature-rich software [15,63]. We encourage researchers developing novel tools to consider gender more explicitly, both during development (e.g. using GenderMag [10] to identify potential software design biases) and in subsequent evaluations. Given that online communities are used widely in conjunction with feature-rich software, it is important that the research community deal with their intersection in a more gender-inclusive way..

5.2 Limitations and Generalizability

Our interviews provide perspectives on two communities for sharing feature-rich software knowledge and shed initial light on gender differences in barriers to contribution. Further study is needed to both ascertain the generalizability of our findings to a broader population and to understand the relative importance of the different barriers. To this end, large-scale detailed surveys (e.g. as in [30]) would be an important complement to our qualitative insight.

To permit wide-scale analysis of existing contributions, our approach involved manually inferring the gender of contributors through their linked profiles, pronoun usage and names, as well as the use of an automated name-based tool for some secondary analysis (e.g. response speed). While we took steps to increase the reliability of our gender labels (e.g. using multiple coders from two countries), and our findings generally align with prior research where users have disclosed their gender directly (e.g. surveys [30]), we acknowledge that our gender classification is likely imperfect. Our findings also do not consider the contributions of those whose gender we could not resolve, and more work is also needed to capture perspectives of those who do not identify with a binary gender classification.

We focused this first investigation on a single feature-rich application for graphic design (Photoshop). Our results are likely to extend to other feature-rich applications (e.g. 3D modelling tools and video-editing suites), where the tools are complex, with numerous ways to approach any given task, and where users often turn to similar online communities for help. A more interesting question for future work is whether different patterns might emerge when it comes to sharing other types of graphic design knowledge, such as strategies for effective visual design, which might be less centred on the use of a technical entity. Future work should also consider other ways men and women share feature-rich software knowledge online, such as through tutorials or livestreams [32].

6 CONCLUSION

In this paper, we present findings from content analysis of two Q&A sites for graphic designers containing both technical and opinion-oriented content and follow-up interviews that answer the question of whether or not men and women are participating equally. Our findings reveal differences in the content and perspectives between men and women who use and participate in these sites, as well as how certain platform dynamics seem to be impacting men and women differently. These results highlight the importance of considering gender in software learning research and tool development and suggest exciting opportunities for the HCI community to work toward technologies that are more gender inclusive.

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