Gender Consideration in the Design of Online Knowledge-Sharing Q&A Platforms

by

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Abstract

Online knowledge-sharing Q&A platforms are valuable sources of learning; however, they do not welcome individuals from different gender groups equally. For example, game features to motivate users' participation, or prevalent communication norms do not similarly affect individuals with different gender identities. In this thesis, we focus on investigating how interface design might aid in promoting a more welcoming and inclusive atmosphere on Q&A platforms such as Stack Overflow. Through an online survey, we investigate how incentive systems used by Q&A communities affect men's and women's motivations to participate. In addition, we present the design and evaluation of a visible social feedback mechanism for inclusion in a Q&A platform to create a more welcoming environment. We explore users' perceptions of this mechanism's potential benefits and drawbacks through an exploratory interview study. Our findings suggest that compared to the men in our study, the women were more open to additional social feedback on Stack Overflow, finding it a potential solution to make Stack Overflow more welcoming. We discuss envisioned benefits of incorporating social feedback into content-focused Q&A platforms and draw attention to the importance of values embedded in the design of game features in such platforms.

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Chapter 1

Introduction

Online sharing communities, such as Q&A communities, play an important role in today's knowledge work. They not only serve as key resources for users needing timely technical, problem-solving and troubleshooting advice, but also provide contributors with a platform to showcase their expertise and skills [4]. For example, recruiters will often look at profiles on sites like Stack Overflow to see developers' experience and skills, and connect with them [5]. It is thus critical from an equity standpoint that these communities work for and appeal to all genders, yet prior research shows that this is far from the case [6–10]. In particular, on Stack Overflow, a popular Q&A platform for software development, less than 10% of members are women [10], despite the fact that, for example, women comprised approximately 24% of computer and information systems professionals in Canada in 2016 [11], with similar numbers in the United States in 2020 [12].

Prior research has uncovered a number of reasons for unbalanced gender representation in online communities. For example, some argue that the disparate impact

of gamification, which is commonly used on Q&A platforms to motivate users' contribution, on women's and men's behaviour might explain why men thrive on Stack Overflow [13]. In this thesis, like prior research in this area, we focus on women's underrepresentation in online knowledge-sharing communities, often comparing their experience and participation to men. While we investigate this issue with an emphasis on the participation of women, we recognize that gender is not binary, with many people identifying as neither a man nor a woman.

One well-documented factor in unbalanced gender representation in online communities pertains to community culture [8, 14]. For example, many users, but especially women, new coders and other marginalized groups find Stack Overflow's environment hostile [15]. Condescending comments [16] and "boy's club" language [8] on Stack Overflow discourage many people from participating and engaging, but this has been especially true for women [8]. A potential contributor to this hostility is the platform's current perceived emphasis on content accuracy, which is often prioritized over posts that are supportive and encouraging. This raises the question of how more pro-social behaviour might be encouraged and rewarded within a Q&A platform, where current game mechanisms (e.g., down/up-votes) tend to reward mainly content accuracy.

In this thesis, we are mainly interested in investigating how interface design might aid in promoting a more welcoming and inclusive atmosphere on Q&A platforms such as Stack Overflow. In particular, we look into the role of game mechanisms in current unbalanced dynamics. We also explore how highlighting peers' social feedback through game mechanisms might help to create an inclusive and welcoming online community. First, we conducted a survey to better understand how the users'

perceptions of commonly used game features might affect the self-reported knowledge-sharing behaviour of users with different gender identities. Then, through an interview study, we explored men's and women's perceptions of rewarding more than merely technically accurate content to promote a welcoming and inclusive knowledge-sharing environment. We also welcomed participants who do not identify as either a man or a woman in our recruiting; however, none of our participants self-identified as non-binary in our pre-screening questionnaire.

1.1   Research Questions

In exploring the role of game mechanisms in gender inclusion in online Q&A communities, we seek to answer the following research questions:

1. How does gender moderate the self-reported effects of commonly used game features on online knowledge-sharing behaviour in online Q&A platforms?

2. How could social feedback mechanisms be used to reward and highlight pro-social behaviour in a Q&A community like Stack Overflow?

3. What are the similarities and differences in how men and women respond to this way of rewarding/highlighting pro-social behaviour?

1.2   Methodology and Approach

We approached our research questions by going through the following steps: 1) we designed and conducted an online survey to explore gender differences in response to different game elements, 2) we designed a social feedback feature and developed

a prototype Q&A website to present the proposed social feedback, and 3) we conducted an interview user study to investigate users' perceptions of the proposed social feedback. What follows is a summary of each of these steps.

1.2.1   Exploratory Survey

To answer the first research question, we designed and conducted an online survey. Analyzing responses from 79 Stack Overflow and Stack Exchange users (50 men, 25 women, and 4 non-binary) indicate that men appear to value ranking and voting more than women, and their perceived competence predicts their knowledge-sharing behaviour.

1.2.2   Designing a Social Feedback Feature

We designed a "Support" feature that allows users to indicate if a post has positive aspects beyond technical accuracy. For example, a user could "Support" a post if it is written with a positive tone or using positive language. They could also "Support" posts from beginners to encourage a more welcoming environment. We propose this "Support" feature as a complement to Stack Overflow's current down/up-vote feedback mechanism. We explored two different ways of rewarding posters who receive "Support" votes: by having these votes contribute towards users' virtual points and by ordering posts according to a combination of down/up-votes and "Support"-votes.

1.2.3 Investigating Users' Perceptions of the Social Feedback Feature

To investigate user perceptions of this new "Support" feedback mechanism, we conducted an interview study with 20 Stack Overflow members (10 men and 10 women). Our findings indicate that users saw a range of potential use cases including encouraging newcomers and recognizing supportive language. Our findings also suggest that the women were more open to having this additional feedback button as compared to the men, and found it a potential solution to make Stack Overflow a safer space to post their questions.

1.3 Contributions

Our work makes the following contributions:

1. We designed and conducted a survey to investigate the relationship between the perception of different game features and self-reported knowledge-sharing behaviour.

2. We propose a Support feature for inclusion in a Q&A platform like Stack Overflow that can act as a complement for feedback that emphasizes technical accuracy.

3. We present findings from an interview study that demonstrate users' perceptions of incorporating social feedback in a content-focused Q&A platform.

The remaining of this thesis is organized as follows: Chapter 2 summarizes prior related research, Chapter 3 presents our exploratory survey design and findings, Chapter 4 introduces our proposed social feedback feature (i.e., Support feature), Chapter

5 describes our interview study to explore users' perceptions of the Support feature, and finally, Chapter 6 concludes this thesis.

Chapter 2

Related Work

Our related work covers prior work on gender differences in knowledge-sharing behaviour. To the best of our knowledge, all of this prior work has focused only on differences between men's and women's online knowledge-sharing behaviour missing the non-binary users' perspectives. We also review related work on approaches to influence and form online behaviours and norms.

2.1 Gender Differences in Knowledge-Sharing Platforms

Prior research has documented numerous important and nuanced gender differences in online communities. These gender differences manifest themselves in different ways, such as levels of representation [17, 18], types of content contributed [19–21], content preferences [9, 22], levels of expertise shown [23], levels of confidence conveyed [8, 14] and validation received [9, 24, 25]. There are also examples where women have to engage in additional emotional labour [26] and adopt additional strategies [27] to contribute effectively, something that men appear to not need to do as extensively.

Considering Stack Overflow specifically, studies have shown that the vast majority of contributors are men [6], with women being active for shorter periods of time [7, 28]. This unrepresentative gender balance is becoming a vicious cycle: women show a preference for interacting with other women [29] and they become more active when they encounter other women [30, 31], yet finding women to interact with on the platform is difficult. Further, Stack Overflow users tend to use masculine rather than gender inclusive language, making women uncomfortable, with many deciding to present themselves as men to fit in [8].

2.1.1   Incentive Systems and Gender Disparity

A potential explanation for the gender gap in online knowledge-sharing platforms such as Stack Overflow might be a disparity in the alignment of their incentivizing systems with the motivational traits of individuals from different gender identities. Since the sustainability of online knowledge-sharing communities depends on the participation of users with fresh content and timely interactions [32, 33], such communities utilize various methods to encourage users' engagement. While many online communities rely on the game mechanisms to motivate contribution, there is some evidence in prior work in other domains that men and women respond to gamification differently [34–36].

Although there are some studies on the impact of game mechanisms on users' contribution, there is a lack of research on gender differences in the effects of incentivizing mechanisms on users' motivation on Q&A websites. For example, receiving up-votes and commenting has been shown to have a positive impact on online knowledge-

sharing [33], or users tend to answer more questions after earning a badge related to answering [37]. However, we do not know to what extent these game features are effective for men and women.

There is some evidence that, compared to women, men are more engaged with game features on Stack Overflow. For example, men use down/up-voting more often than women [28], and earn more reputation points [6, 13, 28], a virtual reward earned through activities such as receiving up-votes. Researchers have proposed a variety of explanations for the gap in men's and women's reputation points. May et al.[13] argue that men's higher competitiveness compared to women might explain why men thrive on Stack Overflow, as they are more engaged in the "game" to earn reputation points than women, which is more of a conjuncture. In this work, through an online survey, we investigate gender differences in response to different game elements and their perceived impact on knowledge-sharing behaviour.

2.1.2 Online Community Values and Unintended Gender Consequences

Another potential factor in gender participation in online communities is the type of content the community values. As Stack Overflow states in their Help Center, opinion-based questions "don't fit our format well" [38], such questions are often closed by moderators or established users who have the privilege to do so. This topic restriction can be a drawback for using Stack Overflow over other platforms, regardless of gender [4]; however, content analysis of Stack Overflow posts shows that compared to men, women ask more subjective questions that raise discussions and use more tentative language [28]. Similar contrasts have been reported in other online

communities [9, 20, 39].

In addition to the types of contributions Stack Overflow encourages, the communication norms seem to penalize women disproportionately. For example, saying "Thank you" is explicitly discouraged on Stack Overflow as comments are "not for socializing" [40]. However, in online interactions, women tend to express their gratitude more frequently than men, and are more concerned about politeness [41]. On Stack Overflow, women post more comments, express their gratitude, and apologize more often than men, and they tend to be more social and use collectivist language in their posts [28]. These communication norms are in contrast to Stack Overflow's more individualistic values [42]. While Stack Overflow treats comments showing appreciation as noise that should be removed, insights from the Stack Overflow Annual Developer survey in recent years have reported that women dislike this policy more than men [43–45].

Our work contributes by investigating an alternative way to share subjective and socially-oriented feedback on a technically-oriented Q&A, with the aim of supporting norms that more women might find appealing. Stack Overflow's down/up-votes are associated with content accuracy and usefulness, and known to be used by men more often than women [28]. Other feedback mechanisms on social media platforms, like giving "+1" and "Likes" to posts have been used to convey social meaning [46] and appear to have stronger appeal among women compared to men [47]. When Facebook added more reaction buttons, they successfully enabled users to react more precisely to posts, increasing the perceived usefulness of the feedback mechanism [46, 48]. Inspired by these successful implementations of social feedback mechanisms,

we therefore explore how adding our own social button-based feedback mechanism can permit Stack Overflow users to communicate more nuanced interpretations of appreciation and social messages, even in a Q&A where the focus is on fast and accurate technical responses.

2.2 Influencing Online Behaviours and Norms

Deviations from online community norms and the effects of deviations have been studied widely in different contexts with varying user perceptions and reactions depending on the platform [49] and user gender [50]. With little fear of consequences, some users engage in rude and unwelcome behaviours [51, 52]. Furthermore, as this behaviour can often appear to be normalized, some people tend to perceive it as typical and accepted in these communities, despite harming others' enjoyment and retention [53]. Stack Overflow has been criticized for its unwelcoming environment, with many users expressing concerns over its not only accepted, but enshrined norms [15, 54–56]. This unwelcoming environment is a deterrent for many users [4, 57–59]. Prior work further suggests that women see this barrier to engagement as more problematic than men [8].

Given the importance of inclusive knowledge-sharing atmospheres, more research is needed to explore practical approaches to minimizing misbehaviour and promoting inclusion and gender diversity. Prior research on regulating online community behaviour has explored a range of sociotechnical practices [60]. One approach has been to use machine learning techniques, such as classification to detect online toxicity and negative sentiments [61, 62]. Accurate detection, however, has proven challenging,

particularly in light of domain-specific vocabulary [63–65]. Automated solutions can also contribute to a sense of unfairness since they cannot always consider the context of a post [60]. Others have proposed and studied social approaches, such as involving peers or moderators. For example, League of Legends, a popular online video game, introduced the Tribunal System in 2011, a platform where volunteers could judge a violation reported by other players [66]. In comparison to more automated approaches, involving community members in content moderation can promote a sense of relatedness to the community and care [67]. However, reliance on moderators alone has been shown to be insufficient in creating a welcoming atmosphere considering the frequency of norm violation on certain platforms [61].

Our work adds to this body of knowledge by investigating a preventive approach to online hostility in a Q&A platform such as Stack Overflow. We propose and study the use of visible peer social feedback as a way of helping more community members contribute to shaping norms. In Chapter 4, we provide our rationale for focusing on social feedback and describe how we incorporated this feedback within a prototype Q&A website designed to mimic Stack Overflow.

2.3   Summary

In this chapter, we described prior research that has explored gender differences in knowledge-sharing platforms. In this thesis, we explore gender differences related to the impact of different game elements on knowledge-sharing behaviour. We also presented prior work on different approaches to regulate online communities. My thesis extends prior work on regulating and moderating online communities by focusing on

a preventive approach through incorporating peers' social feedback to highlight the encouraged behaviours.

Non-binary users are almost invisible in prior work. While we were unable to recruit sufficient non-binary participants to improve this current state-of-the-art, we acknowledge that the lack of research on the gender difference in online knowledge-sharing communities beyond binary categories is a big obstacle to improving gender representation in online Q&A communities.

Chapter 3

Exploratory Survey

Focusing on the role of interface design in promoting or hindering an inclusive Q&A community, we first wanted to investigate the role of commonly used gamified incentive systems. While knowledge-sharing Q&A websites rely on game mechanisms such as virtual badges, reputation points, and ranking to motivate users' participation, how these elements influence users from different gender groups is not well studied. We conducted an online survey to explore how the current game mechanisms on Q&A platforms affect users' motivation and uncover potential gender differences in responses to different game features. In this chapter, we present our questionnaire design and discuss our findings.

3.1 Questionnaire Design Informed by Self-determination Theory

A commonly used theoretical framework for understanding the motivational potential of gamification and how it affects individuals' motivation is self-determination theory

(SDT) and its sub-theories [68–71]. SDT is an empirically based theory of human behaviour that explains how external factors affect people's motivation by satisfying their basic psychological needs. In brief, this theory states that an event will undermine intrinsic motivation if it thwarts basic psychological needs for autonomy (i.e., self-determination), relatedness (i.e., belonging), and competence. In contrast, an extrinsic factor would enhance intrinsic motivation if it supports these needs. For example, positive feedback that leads to perceived competence will increase intrinsic motivation [72].

To better understand how knowledge-sharing of users from different gender groups on Stack Exchange and Stack Overflow are predicted by their response to different game features, we conducted an online survey. In particular, informed by self-determination theory, we wanted to evaluate the perceived psychological outcomes of existing game mechanisms and how these outcomes, in turn, affect users' knowledge-sharing behaviour on online Q&A platforms (Figure 3.1).
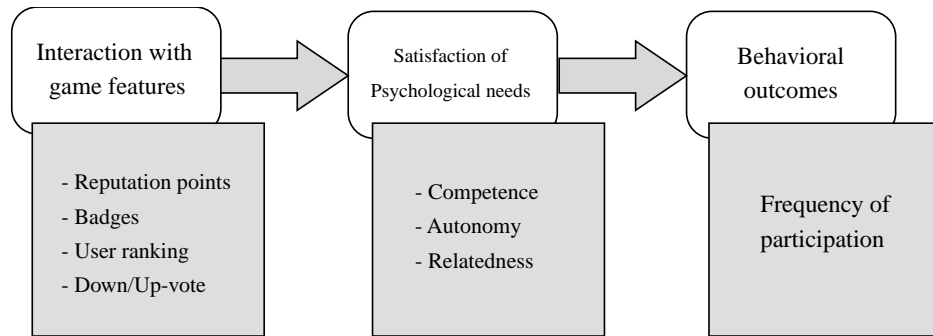
Figure 3.1: The conceptual model of gamification impact on behaviour (adopted from [1])

The survey consisted of four main components: 1) perception of different game features, 2) satisfaction of basic psychological needs, 3) user characteristics and

knowledge-sharing behaviour, and 4) motivational orientations. The first three components correspond to the three main components in the conceptual model (Figure 3.1), and the fourth component assesses individual differences in how people respond to external events (refer to Section 3.1.4). Next, we describe each component of the questionnaire in more detail.

3.1.1   Perception of Game Features

To assess users' perceptions of each game element, in the first component of our questionnaire, we inquired about the importance and frequency of interaction with different game features, including earning badges and reputation points, interacting with user ranking page, and up/down-voting posts. Our questions were inspired by the work of Xi and Hamari [3], which we modified to cover the set of game elements used on Stack Exchange and Stack Overflow, the two platforms we focused on in our survey.

3.1.2   Satisfaction of Psychological Needs

Informed by SDT, the second component inquired about the perceived satisfaction of basic psychological needs: Competence, Relatedness, and Autonomy. We adopted questions from Yoon and Rolland [2] and Xi and Hamari [3] to assess the perceived satisfaction of three basic psychological needs. Table 3.1 displays the questions in this component.

Table 3.1: Survey questions for perceived satisfaction of basic psychological needs [2, 3]

Psychological Need	No.	Question
Competence	C1	I frequently feel like a capable member in this online community.
	C2	Most days I feel a sense of accomplishment in this online community.
	C3	I have been able to provide useful knowledge in this online community.
Autonomy	A1	I feel free to express my ideas and opinions in this online community.
	A2	I feel I can be myself when I visit this online community.
	A3	I feel free from outside pressures when I am visiting this online community.
Relatedness	R1	When I visit this online community, I feel supported by other users.
	R2	When I visit this online community, I feel that I am understood.
	R3	The members of this online community care about me.
	R4	I frequently participate in knowledge-sharing activities in this online community.

3.1.3 User Characteristics and Knowledge-Sharing Behaviour

The user characteristics section of our questionnaire included questions about participants' age, degree, gender, account age, reputation score, the number of questions and answers posted, and their frequency of visiting and participating on the Q&A

platforms.

3.1.4   Motivational Orientations

According to the causality orientation theory, a sub-theory within SDT, individual differences in motivational orientations (i.e. causality orientation) account for some of the variances in the effects of external events (e.g., game features) on people's motivation [73]. There are autonomous, controlled, and impersonal causality orientations, and people have some degree of each of these three. One potential explanation for the gender imbalance of participation in online knowledge-sharing communities might be a disparity in the alignment of their incentivizing systems with the motivational traits of users' from different gender groups. Therefore, looking for gender differences, we decided to incorporate questions on users' motivational orientations in our survey.

In the questionnaire, we used the General Causality Orientation Scale (GCOS)[74] to assess general motivational orientations. This scale includes 12 hypothetical scenarios. Each scenario describes an incident and lists three ways to respond to it (corresponding to each of the three motivational orientations). For each particular response type, the survey asks participants how likely they would be to respond in that way (from 1 for "very unlikely" to 7 for "very likely"). For example: "You have just received the results of a test you took, and you discovered that you did very poorly. Your initial reaction is likely to be:"

	1	2	3	4	5	6	7
"I can't do anything right," and feel sad							
"I wonder how it is I did so poorly" and feel disappointed.							
"That stupid test doesn't show anything" and feel angry.							

While the GCOS assesses respondents' general motivational orientations, the motivational orientations of a person vary in different domains [74]. For example, women might have lower autonomy orientation in STEM fields, which is assumed to reflect a male domain [75]. To assess domain-specific types of motivation in the context of knowledge-sharing platforms, we adopted questions from the Academic Self-Regulation questionnaire [76, 77]. We asked participants three questions about why they participate on the Q&A website, followed by several possible reasons. For each reason, the survey asks the participants to rate it using a 7 points Likert-scale from 1 for "not at all true" to 7 for "very true". For example: "Why do I participate in this online community?"

	1	2	3	4	5	6	7
Because I want the users to think I'm a good member.							
Because it's fun.							
Because I will feel bad about myself if I don't do it.							
Because I want to understand the subject							
Because I enjoy participating.							
Because it's important to me to participate.							

Each of the questions lists reasons representing the different styles of regulation or

motivation: **Introjected** regulation, **Identified** regulation and **Intrinsic** motivation [72]. Introjection is a relatively unstable form of internalization in which people adopt a value, and are motivated to maintain it in order to maintain self-approval. Examples of an introjected motivation to participate in an online community is "*Because I want the users to think I'm a good member.*" Identification is the second type of internalization in which adopted values become personally important for people. An example of an identified motivation to participate in an online community is "*Because it's important to me to participate.*" Finally, an example of intrinsic motivation for participating in an online community is "Because I enjoy participating." The full questionnaire can be found in Appendix B.6

3.2   Participants

Given the potential differences in individuals' motivational orientations in different domains, our recruiting targeted users from three different domains: Stack Overflow, Gardening Stack Exchange, and Graphic Design Stack Exchange. We recruited active members (i.e., posters) and readers (i.e., lurkers) of these three platforms through word-of-mouth and advertising on different online channels (e.g., LinkedIn). 127 participants completed the survey. As compensation for their participation, participants who provided their email address were entered in a draw for one of four 25 CAD gift cards. The survey took about 10 minutes to complete. It was approved by the University of Manitoba research ethics board (See Appendix B.1).

The survey included roughly 1800 words, excluding the consent form. Taking 238 words per minute as an average silent reading rate for adults in English [78], it
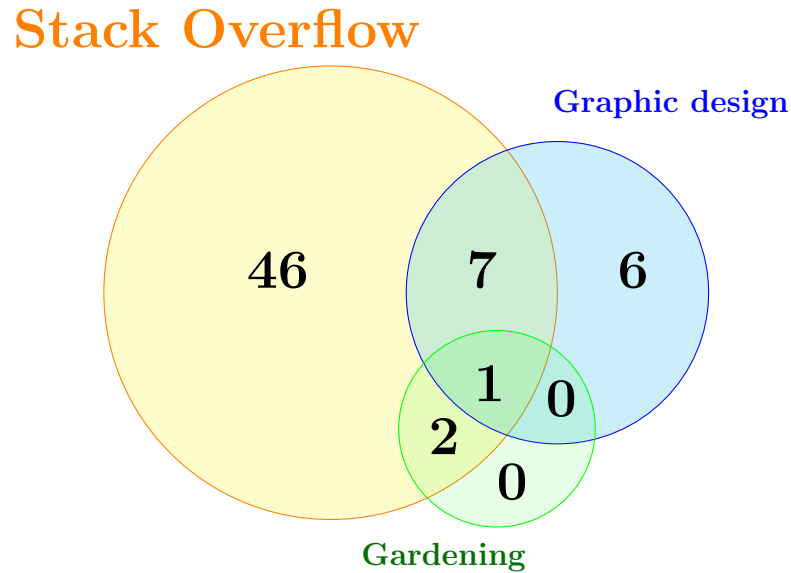
Figure 3.2: Venn diagram illustrating overlap of the 79 participants from the three domains

would roughly take 7.6 minutes to read the questions and answers on the survey. We considered taking at least 6.5 minutes as the inclusion criteria, to make sure that the participant took enough time to read the questions and provide reliable responses. Among the 127 participants, 79 met this criterion and were included in our analysis. The 79 valid responses included 25 women (31.6%), 50 men (63.3%), and 4 non-binary. Table 3.2 presents the percentage breakdown of participants' demographic information and the frequency of their visit to Stack Overflow or Stack Exchange. Among the 79 included participants, 62 (78.5%) participants are members of Stack Overflow, Gardening Stack Exchange, or Graphic Design Stack Exchange, and 17 (21.5%) are users who do not have an account. Table 3.3 presents information of the 62 members. Figure 3.2 displays the overlap of the 62 members from the three domains (participants could be a member of more than one site).

Table 3.2: Demographic and use information of participants (N=79)

		N	%
Gender	Man	50	63.3
	Woman	25	31.6
	Non-binary	4	5.0
Age	18-24	18	22.8
	25-34	52	65.8
	35-44	7	8.9
	More than 45	2	2.6
Education	Hight school or equivalent	8	10.1
	Bachelor's degree	35	44.3
	Master's degree	30	38.0
	Doctorate degree	6	7.6
Visit Frequency	Daily	36	45.6
	Weekly	27	34.2
	Monthly	8	10.1
	Few times a year	8	10.1

3.3   Data Analysis

To analyze the impact of users' gender on the perceived satisfaction of their psychological needs and the perceived importance of different game features for them and their motivational orientations, we applied non-parametric tests as our collected data were not normally distributed. Due to the small number of non-binary participants, we only compared men and women using the Mann-Whitney U test, however we report descriptive statistics summaries for all gender groups. In addition, we

Table 3.3: Information of participants who own an account (N=62)

		N	%
Gender	Man	43	69.4
	Woman	15	24.2
	Non-binary	4	6.5
Account age	Less than 6 months	4	6.5
	6 months - 2 years	15	24.2
	2 -5 years	14	22.6
	More than 5 years	26	41.9
Community	Stack Overflow	56	90.3
	Graphic Design Stack Exchange	14	22.6
	Gardening Stack Exchange	3	4.8
Activity	Never posted	6	9.7
	Only posted question(s)	5	8.0
	Only posted answer(s)	5	8.0
	Posted question(s) and answer(s)	46	74.2
Reputation	1 (Given by creating an account)	9	14.5
	2- 20	9	14.5
	21-100	11	17.7
	101- 1000	12	19.4
	1001-4000	10	16.1
	More than 4000	11	17.7

conducted path model analysis through component-based PLS-SEM (Partial Least Squares Structural Equation Modeling) to analyze the relationship between the conceptual model components (Figure 3.1). We report results as significant if $p < 0.05$ and as potential trends if $p < 0.1$.
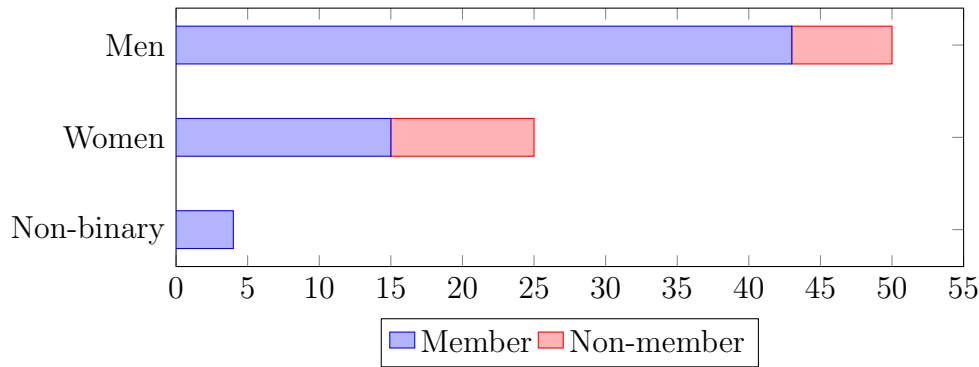
Figure 3.3: Gender distribution of the participants

Despite our initial goal for selecting three different domains (Stack Overflow, Graphic Design Stack Exchange, and Gardening Stack Exchange) to compare participants' motivations and effects of various game elements on their behaviour within different contexts, we did not compare these groups due to the small representation of participants who are solely a member of Graphic Design Stack Exchange or Gardening Stack Exchange. As Figure 3.2 presents, all of the Gardening Stack Exchange members and most of the Graphic Design Stack Exchange members among our participants were also Stack Overflow members.

3.4   Findings

This section describes our findings regarding the perceived importance of interacting with different game features, psychological needs' satisfaction, and motivational orientations. Finally, we present our path model analysis of how knowledge-sharing is predicted by perceptions of game elements through satisfying psychological needs.

Difference in the Perceptions of Game Features

As Table 3.4 illustrates, comparing the importance of interacting with different game features among men and women suggests a potential trend for down/up-voting and interacting with the user ranking page. Men appeared to find interacting with user ranking list, and down/up-voting more important than women. For the non-binary participants, the median (IQR[1]) values for importance of interaction with different game features were as follows: earning badges = 3 (5.5), earning reputation = 3.5 (4.75), user ranking list = 1 (2.25), and down/up-vote = 5.5 (2.5).

Table 3.4: Median(IQR) values for the importance of interaction with different game features for men and women (N=75, binary gender participants). Bolded values are potential trends.

	Range	Men (N=50)	Women (N=25)	*p*-value	U	z
Earning Badges	1-7	3(3.25)	2(4)	0.559	574.0	-0.584
Earning Reputation	1-7	4(4)	3(4.5)	0.588	577.5	-0.542
User Ranking List	**1-7**	**3(3)**	**2(2.5)**	**0.067**	**466.5**	**-1.832**
Down/Up-vote	**1-7**	**6(3)**	**4(3)**	**0.094**	**479.5**	**-1.677**

Differences in Psychological Needs Satisfaction

We looked for gender differences between men and women in the perceived satisfaction of basic psychological needs. Since we were interested in the community member's basic psychological needs satisfaction, the questionnaire items in this component addressed members (e.g. "I frequently feel like a very capable member in this online

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[1]Interquartile range

community"). Hence, we only compared men and women who are members of the considered Q&A communities (N = 58). As Table 3.5 illustrates, no statistically significant differences were found. For the non-binary participants, the median (IQR) values for the three psychological needs were as follows: perceived competence = 14 (14.5), perceived autonomy = 7.5 (15.75), and perceived relatedness = 18.5 (16.5).

Table 3.5: Median(IQR) values for satisfaction of psychological needs for men and women (N=58, binary gender participants who are are community members).

Psychological Need	Range	Men (N=43)	Women (N=15)	p-value	U	z
Perceived Competence	3 - 21	14(6)	11(9)	0.600	293.0	-0.525
Perceived Autonomy	3 - 21	12(6)	12(5)	0.682	299.5	-0.410
Perceived Relatedness	4 - 28	17(6)	15(8)	0.722	302.5	-0.356

We also compared the satisfaction of three psychological needs between posters who earned some reputation points (got some up-votes) with posters who did not. The posters with reputation points reported not only higher perceived competence but also potentially higher relatedness (Table 3.6). We also compared questions related to relatedness for these two groups. As Table 3.7 illustrates, posters who did not earn reputation points feel the community does not understand them, and they do not feel that the community is as friendly towards them compared to posters who earned reputation points.

Bazelli et al. [79] have shown that top reputed posters on Stack Overflow express less negative emotions and are more extroverted compared to the medium and low reputed posters. They conjectured that users who show less negative emotions (e.g.,

Table 3.6: Median(IQR) values for satisfaction of psychological needs for posters with and without reputation (N=56, posters). Bolded values are statistically significant or a potential trend.

Psychological Need	Range	With rep. N=52	No rep. N=4	*p*-value	U	z
Perceived Competence	**3-21**	**14(7.75)**	**7.5(6.5)**	**0.04**	**39.5**	**-2.057**
Perceived Autonomy	3-21	12(6)	8.5(5.5)	0.87	50.5	-1.709
Perceived Relatedness	**4-28**	**17(7)**	**14 (6.75)**	**0.05**	**42.5**	**-1.963**

Table 3.7: Median(IQR) values for Relatedness of posters with and without reputation (N=56, posters). Bolded values are statistically significant.

	Range	With rep. N=52	No rep. N=4	*p*-value	U	z
When I visit this online community, I feel supported by other users.	1-7	4(3)	3.5(3.25)	0.457	81.0	-0.744
When I visit this online community, I feel that I am understood.	**1-7**	**5(2)**	**2(3)**	**0.028**	**36.3**	**-2.194**
The members of this online community are pretty friendly towards me.	**1-7**	**4(1.75)**	**3(2.25)**	**0.019**	**32.5**	**-2.341**
The members of this online community care about me.	1-7	3.5(3)	2.5(3.25)	0.517	84.0	-0.648

anxiety or anger) gain more popularity and reputation points. However, considering the difference in perceived relatedness between posters with and without reputation points (Table 3.7), the posters' perception of community friendliness towards them might be the reason behind negative/positive emotions in their posts.

Prior work also suggested that receiving up-votes has a positive impact on online participation, and receiving down-votes has a destructive effect [33]. Our finding demonstrates how self-determination theory can explain the relationship between game features and the user's contribution rate. Receiving up-votes (which leads to earning reputation points) can cause the satisfaction of competence and relatedness needs and in turn can increase members' motivation to participate.

Differences in Motivational Orientations

As Table 3.8 illustrates, we did not find any significant gender differences in the general causality orientations of participants. For the non-binary participants, the median (IQR) values for the three motivational orientations were as follows: Controlled orientation = 53.5 (11.5), Autonomous orientation = 75.5 (15.75), and Impersonal orientation = 48 (23.5).

Table 3.8: Median (IQR) values for Causality Orientations by gender (N=75, binary gender participants).

Orientations	Range	Men (N=50)	Women (N=25)	*p*-value	U	z
Controlled	12 - 84	48.5 (9)	51(13.5)	0.514	567.0	-0.653
Autonomous	12 - 84	64(12.5)	66(12.5)	0.461	559.5	-0.737
Impersonal	12 - 84	45(12.5)	48(18)	0.218	515.5	-1.232

For domain-specific motivational orientations, we only compared those who are members of the platforms since the domain-specific orientations are regarding participants' motivations for actively participating, which is only applicable to members. However, as in Table 3.9, we did not find significant differences in domain-specific mo-

tivational orientations between men and women. For the non-binary participants, the median (IQR) values for the three domain-specific motivational orientations were as follows: Intrinsic = 19.5 (12), Identified = 21.5 (7.5), and Introjected = 13.5 (10.75).

Table 3.9: Median(IQR) values for Self-Regulation by gender (N=58, binary gender participants who are are community members).

Self-Regulation	Range	Men (N=43)	Women (N=15)	*p*-value	U	z
Intrinsic	5 - 35	23(14)	18(18)	0.147	241.0	-1.449
Identified	5 - 35	21(6)	19(7)	0.373	272.5	-0.890
Introjected	7 - 49	19(12)	15(9)	0.197	250.0	-1.290

Although no significant difference between the two binary genders was found, we found that irrespective of participant's gender, participants rated the questions asking about their Intrinsic Motivation (e.g., enjoying participation) higher than questions about the Introjected Regulation (e.g., participating to build a positive image). To test this observation, we normalized Intrinsic motivation and Introjected regulation variables to range between 1 to 7, and applied the Wilcoxon Signed Ranks Test. The Wilcoxon Signed Rank Test indicated than Intrinsic Motivation Score (Mean = 4.41, SD = 1.695) is statistically higher than Introjected Regulation (Mean = 2.87, SD = 1.238) (Z = 118.5, $p < 0.001$). This difference is illustrated in Figure 3.4. This finding is aligned with prior work [80, 81] which suggests knowledge-sharing is significantly associated with intrinsic motivations such as enjoyment, and strong intrinsic motivation is a key factor in members' continued participation [82].
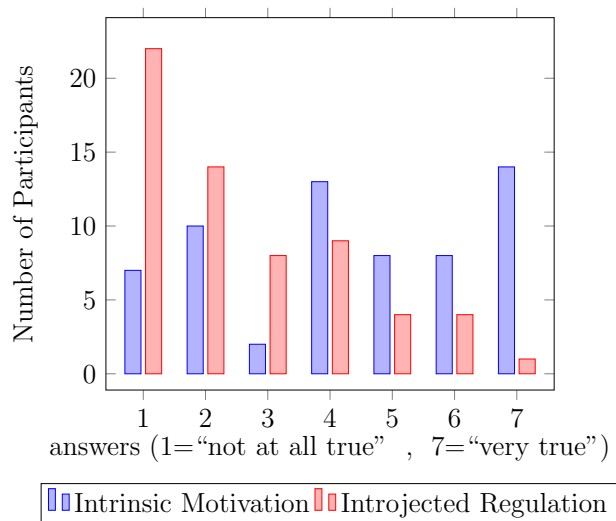
Figure 3.4: Histogram of reported Intrinsic Motivation and Introjected Regulation

Satisfaction of Psychological Needs' Effect on Knowledge-Sharing

We analyzed the path model illustrated in Figure 3.5 using component-based PLS-SEM (refer to Appendix B.7 for assessment of validity). The model explained 55.5% ($R^2 = 0.555$) of the variance for knowledge-sharing behaviour of the members. The results show that knowledge-sharing behaviour is positively associated with competence need satisfaction ($\beta = 0.665$, $p < 0.001$).

To further investigate whether this association is different between men and women, we analyzed the path model for men and women separately. We could not analyze the path model for non-binary participants due to the small sample size. As Figure 3.6 illustrates, the association between competence and knowledge-sharing (competence $\rightarrow$ knowledge-sharing, $\beta = 0.731$, $p < 0.001$), reputation and competence (reputation $\rightarrow$ competence, $\beta = 0.525$, $p < 0.001$), and vote and competence (vote $\rightarrow$ competence, $\beta = 0.253$, $p < 0.005$) are only significant for men. On the other hand, perceived relatedness is associated with badges for women (badges $\rightarrow$ relatedness, $\beta = 0.884$,
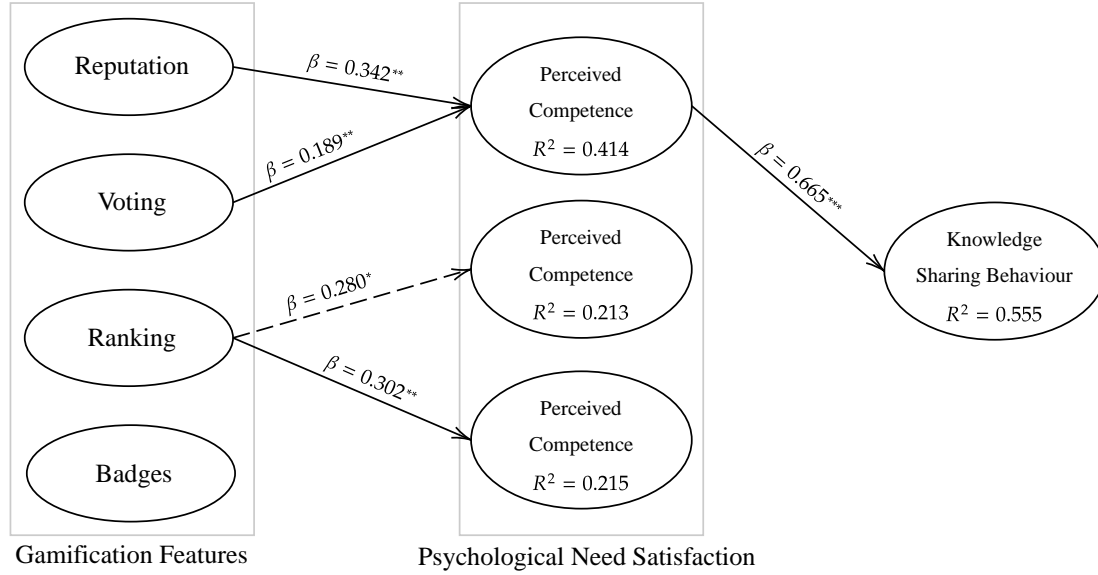
Figure 3.5: Path model findings.

The solid arrows represent significant associations. The dashed arrow represents a potential trend.

R^2 = coefficient of determination, β = path coefficient, $p < 0.01^{***}$, $p < 0.05^{**}$, $p < 0.1^*$

$p < 0.005$). We have also used multi-group analysis to test whether differences among men and women are significant. Table 3.10 demonstrates the significant differences between path coefficients among men and women.

Table 3.10: Multi-group analysis of SEM for men and women

	β (Men)	β (Women)	p-value (Men vs. Women)
Vote $\rightarrow$ Competence	0.2526	-0.5864	0.006
Badge $\rightarrow$ Relatedness	-0.1811	0.8839	0.0385
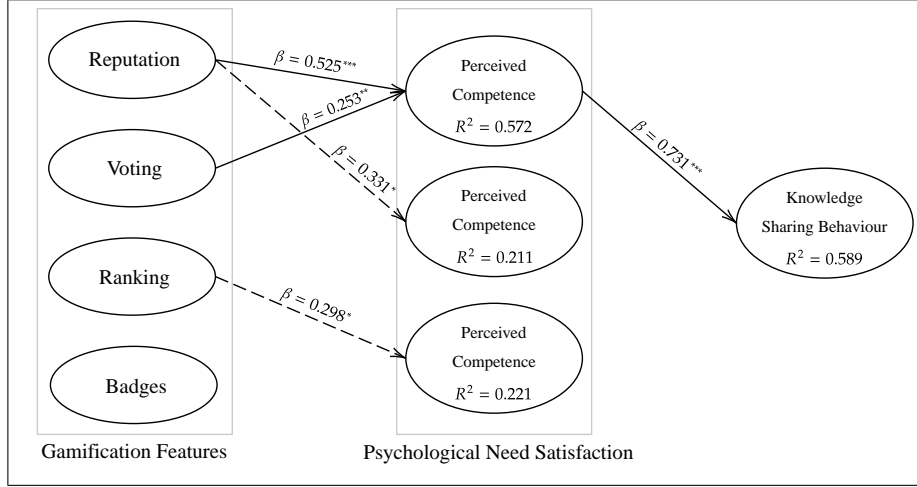
(a) Path model analysis for men
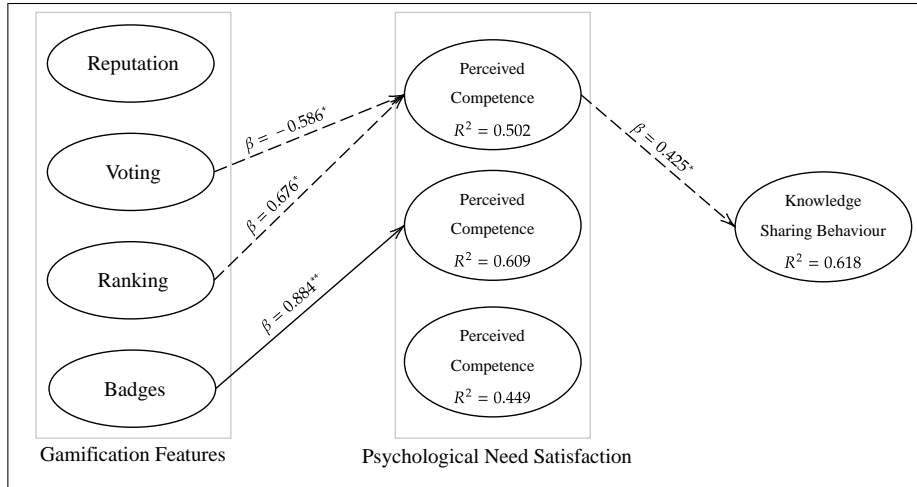
(b) Path model analysis for women

Figure 3.6: Path model analysis for men and women.

The solid arrows represent significant associations. The dashed arrows represent potential trends.

R^2 = coefficient of determination, β = path coefficient, $p < 0.01$***, $p < 0.05$**, $p < 0.1$*

3.5   Discussion

In light of self-determination theory, we explored how different game elements influence online knowledge-sharing through driving intrinsic motivation and satisfying basic psychological needs in men and women based on the data (N = 79) collected from Stack Overflow and Stack Exchange users. Although the underrepresentation of women and non-binary users in our collected data is a shortcoming of our survey, we could see some interesting trends when comparing men and women. Further research is needed to explore the impact of game features on non-binary users' motivations to participate in online Q&A platforms.

Men appeared to value ranking and voting more than women. In addition, for men, the frequency and importance of voting and earning reputation points are predictors of competence need satisfaction which in turn positively influence knowledge-sharing. In contrast, we could not find a strong predictor of knowledge-sharing for women. While this difference could be due to the smaller sample of women, we can explain it differently by taking prior work into account.

While online communities employ some game features intending to increase their motivation, it might be counterproductive for some users. For example, reputation points as a way of quantifying achievements and ranking as a means of positioning achievements against others create a competition among users aiming to involve them in the "game" of earning more reputation points. Engaging in this competition might increase users' motivation by satisfying their need for competence. Yet, women are less likely to enter competitions than men, and their performance can reduce under competitive pressure, especially in stereotypical-male domains [83]. Therefore, game

elements such as ranking might become counterproductive for women and undermine their intrinsic motivation by thwarting their perceived competence.

Given that the current competition seems to favor men disproportionately [7, 13], offering less-competitive incentives might help to promote inclusivity on Stack Overflow. For example, the competitive nature of the current reward system on Stack Overflow caused the "Fastest Gun in the West" problem, which means users try to post brief answers quickly to gain more points [82, 84] since being the first one to post an answer to a question is one of the strategies that helps to increase reputation quickly [85]. However, since women are less likely to engage in this competitive speed-oriented game, providing less-competitive alternatives could remove obstacles for women's engagement. In the next chapter, we take a step on this path and explore a reward mechanism that we speculate to benefit women by 1) being less competitive and 2) promoting a more welcoming and supportive environment.

3.6 Summary

In this chapter, we described our questionnaire design and online survey findings. Our findings showed that men's knowledge-sharing is predicted by their competence need satisfaction. However, we did not see such a predictive relationship for women's contributions. In addition, we did not find any significant differences in men's and women's motivational orientations. In the next chapter, we describe a social feedback feature we introduced as a less competitive complement to the current down/up-vote to highlight and motivate pro-social behaviour.

Chapter 4

Incorporating Social Feedback

Intending to modify the current incentive mechanisms to make it less-competitive, to promote women's engagement, and to create a more welcoming community, we propose a social feedback feature to complement Stack Overflow's current down/up-vote mechanism. This chapter describes this social feature and how we developed a prototype to investigate users' perceptions around the proposed feature.

4.1   Incorporating Social Feedback on Content-Focused Q&A Platforms

Feedback plays a significant role in reinforcing accepted online behaviour [86, 87]. It can consist of "task feedback" and "social feedback" and emphasizing one type of feedback over another can influence a community's interactions and define what is valued [87]. Task feedback relates to the perceived usefulness of the offered post [87]. Stack Overflow enables members to give their feedback on the quality of contributions through down/up-voting. The down/up-votes on Stack Overflow tend to be used as

task feedback reflecting the usefulness of the posts. On the other hand, social feedback relates to the behaviour and attributes of the poster [87]. Stack Overflow's Code of Conduct (CoC) advocates friendliness [88], but frequent violations of the Code of Conduct have created a toxic atmosphere [61] and visible social feedback regarding user behaviour is absent.

Considering the critical role of feedback in group norm reinforcement [89] and the importance of social and task feedback balance [87], we are interested in investigating visible social feedback to complement the current sole emphasis on the technical usefulness of posts (i.e. task feedback). To investigate user perceptions towards social feedback on a content-focused Q&A platform like Stack Overflow, we introduce a Support button as an additional way of reacting to answers and comments in addition to down/up-votes to highlight other important values on a post, for example, language, tone or posters' attitude towards beginners and encourage pro-social behaviour. Pro-social behaviour refers to "discretionary behaviour such as assisting, comforting, sharing, and cooperating intended to help worthy beneficiaries" [90]. While knowledge-sharing through online platforms such as Stack Overflow is a voluntary action that can benefit the community, here we regard pro-social behaviour as conforming to community values and accepted behaviours (for example, friendliness [88]).

For the Support button, we wanted to pick an icon that emphasizes the non-technical nature of this new reaction feature, and that is applicable to different scenarios. After iterating on multiple icon designs (Appendix C) and eliciting informal feedback, we found that LinkedIn's support reaction icon, represented by hands hold-

ing a heart best fits our requirements: it depicts the non-technical nature of the Support feature, does not conflict with commonly used icons in other social media, and the hands holding the heart could impart a sense of offering support.

We added a Support button next to each answer and comment. Similar to up-votes, the number of Support-votes received is displayed next to the Support button for comments and on the button for answers and questions (Figure 4.1).
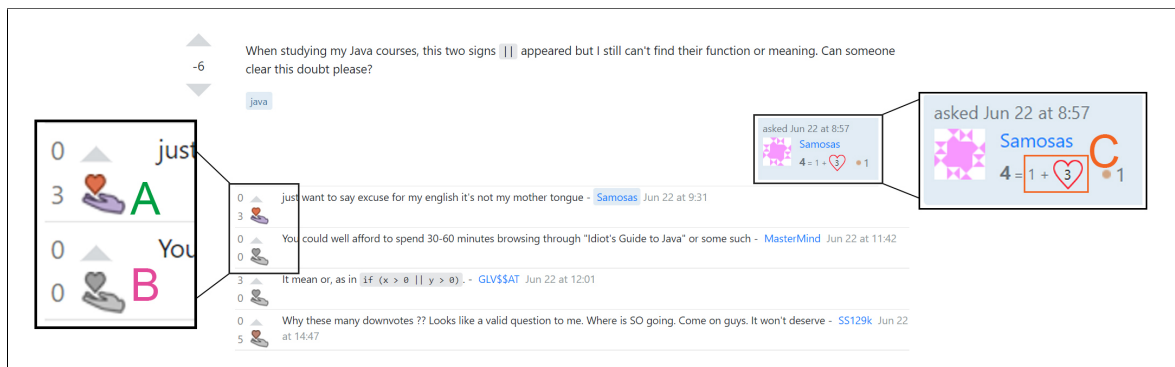
Figure 4.1: A sample answer in a prototype Stack Overflow interface (referred to the Points Interface) - The Support button icon has different colours depending on whether a comment or an answer is Supported or not. (A) A "Supported" comment (B) A comment with no Support-vote (C) The number of regular reputation points and Support-points the user has received.

On Stack Overflow, down/up-votes impact both contributor recognition and content emphasis: down/up-votes contribute to posters' reputation points and change the order in which answers are displayed in a question thread. Correspondingly, to elicit feedback on different ways a new reaction button can highlight and reward prosocial behaviour, we designed two variations of our prototype: a **Points Interface** and an **Order Interface**. In the Points Interface, posters earn one reputation point for each Support-vote they receive. Points earned by Support-votes, Support-points, are displayed in the user profile. These Support-points are also shown below the posts inside a heart-shaped icon (Figure 4.1). The Order Interface orders answers by

summing the number of Support-votes and up-votes answers received.

4.2   Prototype Interface

To explore users' perceptions and acceptance of the additional reaction button, we implemented a prototype of a Q&A interface that served to prompt participant reflection on how they might use an additional reaction button and how it may affect their engagement with Stack Overflow. To this end, we made the prototype Q&A's layout and appearance (e.g., font family, font size and colours) as similar as possible to Stack Overflow's (see Appendix D.5 for screenshots). We implemented the prototype as a web application using Bottle, a Python web-framework. To this prototype, we added the Support button next to each answer and comment as described in the previous section (and shown in Figure 4.1).

4.3   Summary

In this chapter, we described our suggested social feedback feature and our prototype interfaces. Given the role of feedback in reinforcing accepted online behaviour, we proposed a Support feature to highlight and reward pro-social behaviour, in addition to technically helpful content. The next chapter describes how we used the developed prototype to study the users' perceptions of the social feedback feature.

Chapter 5

User study: Exploring Users' Perceptions of the Social Feedback

In this chapter, we describe our interview study. Using the prototype described in the previous chapter, we investigated users' perceptions of the added social feedback feature, its potential use cases, envisioned impacts on community dynamics, and similarities and differences in how men and women respond to this feature.

5.1 Participants

We recruited 20 members of Stack Overflow (10 self-identified as men and 10 as women) through word-of-mouth and advertising on social media websites (e.g., Reddit). We administered a pre-screening questionnaire that included an open-ended question on gender identity and used responses to this question to recruit an equal number of men and women. Our pre-screening questionnaire and recruitment also welcomed participants who did not identify as either a man or a woman, however,

unfortunately we were not able to recruit any non-binary participants. We acknowledge that further research is needed to include the view of non-binary users to explore mechanisms for an inclusive and welcoming online community.

Based on participants' self-reports, nine visit Stack Overflow daily, nine weekly, and two monthly. Five participants were members of Stack Overflow for more than 5 years, seven for 2-5 years, six for 6 months-2 years, and two for less than 6 months (Refer to Table 5.1 for the gender distribution). Participants received $20 CAD after signing the consent form.

Table 5.1: Account age and visit frequency of participants by gender

Account Age	Women	Men	Total	**Visit frequency**	Women	Men	Total
more than 5 years	2	3	5	Daily	5	4	9
2-5 years	4	3	7	Weekly	4	5	9
6 months-2 years	3	3	6	Monthly	1	1	2
less than 6 months	1	1	2				

5.2   Study Design

Our primary focus was on qualitative data from the interviews and qualitative analysis. However, we also included two (between-subjects) study factors to investigate how perceptions might change given i) potential uses of Support-votes within the Q&A platform and ii) gender of participants. The first factor was Interface Type, which had two levels corresponding to our two interfaces: the Points Interface and the Order Interface. Descriptions of these interfaces can be found in Section 4.1. We used these two interfaces to prompt users to reflect on rewarding and highlighting

pro-social behaviour on the platform. Self-identified gender was our second between-subjects factor. We assigned participants to an Interface Type randomly, balancing the number of men and women per Interface Type.

5.3   Q&A Content

To populate our prototype Q&A (see Figure D.2) with ecologically valid data, we collected questions, answers and comments from Stack Overflow's archive using the following popular tags: Python, Java, C++, CSS and SQL. Since our focus was on the Support feature and not the Q&A content, we selected questions that seemed simple and not too long. We also collected a range of comments from Stack Overflow archival data showing frustration, sarcasm, gratitude, and support (see Table 5.2 for sample comments). We used a manual process for selecting content for the prototype, so our aim was to include enough content that participants could explore the Support feature in a variety of situations while being mindful of resources. We included 8 questions, 14 answers, and 26 comments, which pilot testing suggested provided participants with sufficient content to explore the prototype.

5.4   Procedure

Our study sessions were held online using a video-conferencing platform of participant's choice due to COVID-19 and lasted approximately 60 minutes. Each session started with an informal introduction in which we shared a link to the prototype with the participants. Participants then had 15 minutes to interact with the prototype, during which time we asked them to read at least 3 question threads, explore user

Table 5.2: A sample the comments used in the prototype

Type	Sample Comment
Sarcasm	I found on Yahoo a nice website: google.com It's really nice, you should try it
Support	ignore the negative votes. it is a good question :)
Self-disclosure	Oh and be gentle bit of a newbie...
Gratitude	Wow. Speechless. Thank you so much. I know a lot of people would say "Google it" but I have, and it is difficult to ask Google something when you are not sure of the parameters of your own question.
Frustration	Thanks. I dunno why I made this mistake, and unfortunately as i recall, I made the same mistake in the midterm too. :(

profiles and to use the down/up-vote and Support buttons when they saw fit. Our informal pilot testing suggested that this duration provided sufficient familiarization for the semi-structured interviews, which was our primary data collection method. Since our focus was on community reactions to posted content, we did not ask participants to contribute any new content. Prior to participants interacting with the prototype, a guided tour demonstrated how the Support feature changes the recipient's reputation points in the Points Interface or ranks answers in the Order Interface. We monitored participants' interaction with the prototype through real-time logging as opposed to asking them to share their screens.

After interacting with the prototype, participants answered a short questionnaire comprised of three Likert-scale questions on their acceptance of the Support feature. Finally, we conducted a semi-structured interview where we asked participants about their attitudes towards the Support feature, how they used the feature while interacting with the prototype, and their views on potential use-cases, benefits, and draw-

backs. During the interviews, we also introduced the Interface Type that participants did not experience to elicit preliminary comparative reactions.

5.5   Data Collection and Analysis

Our primary source of data was from the semi-structured interviews. We also collected participants' interaction data with the prototype (e.g., uses of up-votes, down-votes and Support buttons), and their responses to the post-interaction questionnaire.

To analyze the interviews, I first transcribed them in full and then created affinity diagrams of participant quotes (Figure 5.1). I grouped quotes about similar topics or feelings and developed initial themes. To lessen my own implicit biases, I removed gender tags from participants' quotes during this phase. After developing initial themes, I added the gender labels and looked for gender differences in the collected quotes and themes. Along with my advisor, we collaboratively revised the themes, revisiting the raw data frequently. In doing so, I also looked carefully for any counterexamples to our developed themes.

Being aware of the complexity associated with gender-based analysis [91] and given our small sample size, we did not expect clear gender distinctions to emerge from our interviews. We uncovered subtle gender differences in our findings that we ground in prior work, which like our study, has mostly explored differences between men and women, in order to have a better grasp of potential benefits of a social feedback feature.

To analyze the quantitative data, which was not normally distributed, we used the non-parametric Mann-Whitney U test. We report results as significant if $p < 0.05$.
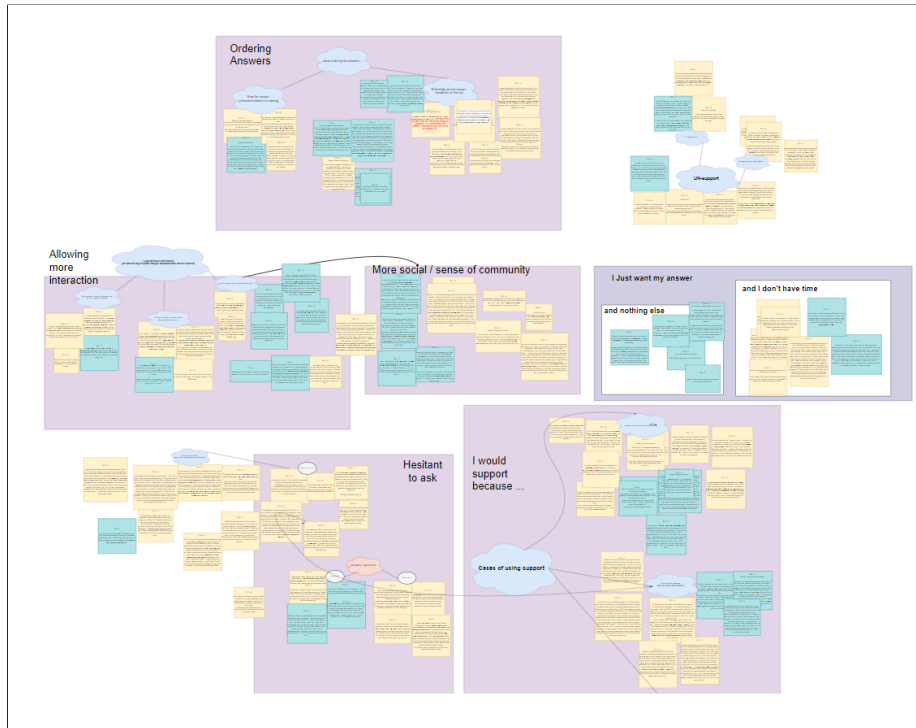
Figure 5.1: A segment of our Affinity Diagrams created using the Draw.io desktop application

5.6   Findings

5.6.1   Interview Findings

We begin by presenting key themes from our interview data along with supporting quotes. Note that we use man (/woman) to refer to a participant who self-identified as a man (/woman). We use the annotations M and W to denote quotes from men and women, respectively. For most themes, we saw evidence of these perspectives across both the men and the women. We explicitly note any gender differences that we observed.

5.6.1.1 Towards Making Stack Overflow a More Welcoming Space

One of the dominant themes that came from our interviews was the potential impact of having social feedback on creating a welcoming environment on Stack Overflow. Participants described how the Support feature could potentially be used to encourage newcomers, create a safer space and complement community moderation. We describe these perspectives in more detail below.

Recognizing supportive language and encouraging newcomers

We intentionally avoided providing detailed instructions on the purpose of the Support feature to allow potential use cases to emerge from participants. In the interviews, most participants felt that they understood the intent behind this feature and described cases where they could see themselves using it.

Notably, most of the suggested use cases focused on welcoming and encouraging newcomers either by recognizing supportive language, especially towards newcomers, or by explicitly supporting newcomers whose posts suggest that they lack confidence. In the case of the latter, the goal was to Support these posts to help boost confidence.

> *So I felt that the Support button was a really nice way to say "Oh, actually thank you for being nice". [W06]*

> *I would Support a question that was exposing the person's insecurities. and I would Support [that] to show them that "it's okay if you don't know this. We all have been there, that's OK." [W04]*

Participants who wanted to encourage the newcomers could empathize with comments with some levels of self-disclosure, such as when a user expresses that they are new to a specific language or framework, shows lack of confidence, or apologizes for

posting a question. They wanted to encourage these types of comments either because someone did the same thing for them when they were newcomers or because they had experienced discouraging reactions on Stack Overflow in the past and understood how intimidating such reactions can be.

Being aware of Stack Overflow's hostility towards newcomers, participants described wanting to use the Support feature to welcome and encourage them. Concern about hostility towards new users, which makes them hesitant to contribute [57], is an ongoing issue that has existed from the early days of Stack Overflow. For example, the question "Could we please be a bit nicer to new users?" is currently the fourth-most voted question on Meta Stack Exchange. This question was originally asked in September 2008, less than two months after Meta Stack Exchange went live [54].

The women found the Support feature as a potential solution to make Stack Overflow a safer space

In our interviews, more women than men seemed open to the Support feature and provided more tangible use cases where they could see benefit. This could suggest gender differences in how men and women are responding to Stack Overflow's communication norms.

While some participants described negative reactions they have seen or personally faced on Stack Overflow towards questions that other users found simple, only women mentioned that these negative reactions deter them from posting.

> *I've noticed over the years that sometimes people are not nice and they say "oh this is easy. Why are you asking here?" […] I would not post a question sometimes and I guess it's because of it. [I'm] a bit afraid of getting weird answers. [W06]*

Fear of negative feedback is known to be one of the barriers for women's engagement on Stack Overflow [8]. All the women who expressed hesitation to posting questions saw the Support feature as a potential solution to make Stack Overflow more welcoming to simple questions and beginners, and to help create a more inviting atmosphere by encouraging new and established users to compete to earn Support-vote by being "nice".

> *[With the Support feature] Someone like me would be less scared to just write his or her questions there and then be active in the community. So I would look at it as a safer community that way. Because people [would be] competing to be more kind, more polite. [W02]*

On the other hand, a few participants, most of whom were men, could not differentiate between Stack Overflow's regular up-votes and the proposed Support-vote.

> *I assumed Supporting is monetary. When you have something like vote if the Support is not monetary, then what's [the] point compared to [the] voting system? It's something redundant unless it has a different rewarding mechanism than just votes. [M05]*

Users also want to react to unkindness

Some participants mentioned that they would like a negative version of the Support feature to report mean comments. This urge to do something about toxic behaviour seems to come from personal negative past experiences and disappointment when moderators did not get involved in the way participants hoped. A few participants mentioned that this report should have consequences for the recipients, such as restricting their access to the platform.

> *We need to kind of restrict those people who are mean, because they are likely [to] discourage [other users]. And those people who get so many negative points for un-Support [should] be banned for a while or they [should] get a warning. [W07]*

There is a flag button on Stack Overflow to report unacceptable behaviour, however, participants mentioned that a mean comment might not necessarily be flag-worthy in light of Stack Overflow's policies. They felt that having a negative version of the Support feature could help them express their opinions without waiting for another moderator to approve their report, which might never happen.

> *I use the flag very, very rarely. Only when it's abusive. I haven't flagged things when they're just mean 'cause is that flag worthy? I'm not sure. They're a couple [of] times I've used flags. And actually, people have said "no, you're using it wrong". [M04]*

Although Stack Overflow relies on community moderation, including casting votes on the posts or choosing official moderators in a formal vote, we saw hints of preference for self-governance and less focus on moderators regarding content moderation. Exploring questions posted under the "declined-flags" tag in Meta Stack Overflow, also manifests users' frustration when moderators decline their flag. For example, when a user believed a username with misspelled offensive words ("YuckFou") should not be allowed on Stack Overflow, his flag was declined by the moderators [92]. Considering the subjectivity of what users find inappropriate [65] and the unlikelihood of having a perfect consensus in a large community [93], social feedback can potentially give more of a voice to members.

5.6.1.2   Promoting Community Interactions

From the participants' perspective, one of the contrasts between the Support feature and up-votes was that the Support feature enabled the participants to interact with other members and, therefore, promote a sense of community.

To down/up-vote, participants felt they needed to have appropriate topic expertise. Some participants described down/up-voting an answer or a comment as a responsibility because users, including themselves, rely on votes to choose the correct answer. Stack Overflow's guidelines describe up-votes as indicators of "useful and appropriate" questions and answers [94]. Although each user may have their own interpretation of what is a useful and appropriate post, participants seemed to internalize Stack Overflow policies favoring factual, informational answers. They mentioned that down/up-voting requires evaluating whether an answer is factually correct, which they felt carries a degree of pressure:

> *I think with up-vote I have to know that the answer works, the solution that's been provided works. So I feel like with the up-vote button there's such a pressure to be an expert in the field that has been discussed. [W05]*

With the Support-vote, participants saw the opportunity for greater community interaction. Even if they could not fully certify an answer's correctness, they welcomed the opportunity to interact with contributors without the risk of violating Stack Overflow's policies. They felt that this type of community interaction could help make Stack Overflow less impersonal, and humanize the community. Impersonal interaction is one of the main barriers that discourage women from participation on Stack Overflow [8]. Irrespective of gender, social interactivity promotes knowledge-sharing on Q&A websites [95] and has a positive effect on the quality of shared knowledge [96].

> *I think that the Support feature is more of an emotional describer versus up-vote [which] is strictly [saying] you provided technical information. [W05]*

> *On platforms like Stack Overflow. You don't interact very much with people. You're just passing by people's comments and answers and questions.*

> *And they are just, anonymous boxes with weird designs. I think this [Support feature] adds a human factor to it. [M06]*

Alternatively, a few participants, most of whom were men, were not sure if social community interactions belong on Stack Overflow.

> *Maybe I would comment more [if Stack Overflow implements the Support feature]. And others too. But I don't know if commenting [more] goes well with the purpose of that kind of community. [M01]*

For these participants, the existing interaction norms appear to be working and therefore, they did not see value in a design that seeks to alter these norms.

5.6.1.3   Rewarding Pro-social Behaviour Without Mixing the Technical Aspect

In our study, we investigated two ways to incorporate Support feedback that mirror the way down/up-votes are currently utilized on the platform. Of the two approaches, most participants liked the idea of awarding reputation points to recipients of Support-votes, however, they wanted the two dimensions of reputation to be separated so that they could distinguish "knowledgeable" from "nice" users. They felt that a clear indication of knowledgeability is essential to assessing the reliability of a user's answers.

> *I think what we're supposed to be using [the] reputation for is to kind of assess how trustworthy this person's answer is. [...] I guess I'd like to be able to tell the difference, is this a person who's technically accurate and knowledgeable and are they nice too? [W03]*

Using Support-votes to influence content emphasis was greeted with much less enthusiasm. Most participants did not want answers ordered based on the summation

of the number of up-votes and Support-votes they received. Participants mentioned that they want to see the most accurate answer on the top and they rely on the number of up-votes to choose the answer for their question while exploring Stack Overflow.

> *So basically if the Support button has an emotional aspect attached to it and you're adding up this Support and up-votes together, then we might not necessarily be showing the most appropriate or the strongest answer to the question [on top]. [W08]*

While not the dominant opinion, there were a couple of participants who liked the idea of combining Support-votes with up-votes to highlight answers from "nice" users.

> *If Support could give more attention to those helpful and kind guys, I would definitely prefer to see them. A combined point, based on Support and up-vote [...] those couple of responses there would more appeal to me. [W09]*

Thus, participants were open to the idea of having this type of pro-social behaviour rewarded by the platform, but most did not want to see it influence how answers are presented.

5.6.2 Quantitative Results

5.6.2.1 Feature Usage

Table 5.3 shows how both men and women interacted with the prototype. The men down-voted posts and up-voted comments significantly more often than the women. This finding agrees with prior work showing men are more engaged in down/up-voting on Stack Overflow [28]. The remaining differences were not significant, however,

Table 5.3: Median (IQR) values for participants interaction with the prototype. Bolded values are statistically significant.

	Women	**Men**	***p*-value**	**U**	**z**
Supported answers	2.0 (3.5)	3.0 (2.75)	0.136	30.5	-1.491
Supported comments	2.5 (1.5)	3.0 (2.25)	1.0	50	0.000
down-voted posts	**0.0 (0.25)**	**1.5 (2.25)**	**0.049**	**27**	**-1.973**
up-voted posts	4.5 (4)	6.0 (6)	0.543	42	-0.608
up-voted comments	**0.0 (1.25)**	**1.0 (2.5)**	**0.014**	**19**	**-2.460**

this is not surprising given the participants' short exposure to the prototype. Some participants also mentioned that they were simply trying out the Support feature as opposed to expressing their opinions in certain instances. We also tested whether feature usage was different between our two Interface Types (the Points Interface and the Order Interface), but did not find any statistically significant differences.

5.6.2.2 Questionnaire Responses

As illustrated in Table 5.4, we did not find any statistically significant differences between the men and women in their responses to the post-interaction questionnaire items. On average, women did respond slightly more positively to the Support feature, however, there was also a lot of variability in the data. Part of the variability is likely owing to the fact that we allowed participants to derive their own meaning to the Support feature, which appeared to impact responses. The interviews provided us with the opportunity to probe further into participants' reactions. There was also no statistically significant difference between responses from participants who interacted

with the Points Interface, and those who explored the Order Interface (Table 5.5).

Table 5.4: Median (IQR) values for the post-interaction questionnaire items by gender

Item	Range	Women	Men	p-value	U	z
I would consider using the Support feature if it is available on Stack Overflow.	1-7	6.5 (4)	5.0 (3)	0.534	42	-0.621
If Stack Overflow includes the Support feature, I think the members will use it.	1-7	5.5 (3)	5.0 (3)	0.535	42	-0.621
The Stack Overflow community would benefit from the Support feature.	1-7	6.5 (2)	5.5 (2)	0.328	37	-0.978

Table 5.5: Median (IQR) values for the post-interaction questionnaire items by Interface type

Item	Range	Order Interface	Points Interface	p-value	U	z
I would consider using the Support feature if it is available on Stack Overflow.	1-7	5.5 (4)	5.5 (3)	0.846	47.5	-0.194
If Stack Overflow includes the Support feature, I think the members will use it.	1-7	5.5 (3)	5.0 (3)	0.535	42	-0.621
The Stack Overflow community would benefit from the Support feature.	1-7	5.5 (2)	6 (3)	0.907	48.5	-0.117

5.7   Discussion

Our interview study results indicate that participants could see potential applications for social feedback to encourage newcomers and appreciate supportive language. Women, in particular, found it a possible solution to overcome their hesitation to post their questions, where they currently fear negative reactions from peers. Here, in light of prior work, we discuss how integrating social feedback into Q&A platforms might promote diversity.

Stack Overflow's down/up-vote binary, which is associated with technical usefulness and known to be used by men more than women [28], is not expressive enough for highlighting other important values exhibited by a post, including the language, tone or posters' attitudes towards beginners, all of which can be critical for creating a more welcoming atmosphere. Our interviews indicated that social feedback can potentially complement down/up-votes and can be a way to express the values down/up-votes cannot. Women seemed more open to the idea of using social feedback than men, especially since they cannot currently give this feedback according to Stack Overflow's policies [43, 44].

One potential use case for the Support feature highlighted by participants was to show appreciation. While Stack Overflow guidelines explicitly discourage users from saying thank you, women dislike this policy more than men [43–45]. Participants saw the Support feature as a potential workaround for Stack Overflow's restrictive policies. A recent analysis of a random sample from Stack Overflow archival data shows that women users gave praise and expressed gratitude significantly more often than users who are men [28]. Prior research also suggested that women benefit from

expressing their gratitude more than men [97].

We learned that in parallel to our research, Stack Overflow conducted a one-month experiment by adding a "thank-you" icon beside each post to enable users to show their gratitude without leaving a comment, in response to the increasing number of "thanks" comments and to reduce moderators' burden [98]. However, the test of this reaction feature was met with very negative reactions from active members who believed this feature to be a step towards converting Stack Overflow to a social networking site [99] . Our results, on the other hand, suggest that adding social feedback could be perceived to promote social interactivity and that most of our participants welcomed this idea as a way to create a warmer atmosphere. The contradiction between our findings and community reaction to the added reaction button emphasizes the importance of including different members' views instead of focusing on louder voices from established members, who are satisfied with the current dynamics of the community and benefit from the status quo.

Another potential use case of the Support feature mentioned by the participants, was giving encouragement to a user who apologizes for asking their question. Since we know that women post apologetic content on Stack Overflow significantly more often than men [28], it is possible that using the Support feature as a reaction to a user apologizing for their posted question could help embrace women and encourage them to engage with the community.

Although these two use cases showcase the potential of advancing towards a more welcoming environment for women, we emphasize the nuanced nature of gender research. We looked for gender differences in our findings and also consulted prior

gender research to discuss potential benefits of adding social feedback in a content-focus Q&A platform for women, however, we acknowledge that this way forward might not be suitable for all women and that some might not be interested in social feedback. We are particularly mindful of re-enforcing stereotypes and oversimplifying people [100].

Regardless of gender, through the curb-cut phenomenon, other groups of users, like potentially new programmers, other marginalized groups [15] and even men overall [101], might benefit from adding a social feedback as well. For example, interview participants described how the social feedback can potentially promote community interactions and reward pro-social behaviour. Stack Overflow is known to have a strong individualistic culture, which discourages participation from people who have more collectivist attitudes [42]. Our findings suggest an avenue to promote participation beyond just women, but also from users with more collectivist attitudes.

5.8   Summary

We investigated how a Support feature on a Q&A site could be used by community members to give social feedback. Our results from interviews with 20 Stack Overflow members suggest that a social feedback feature can potentially play an important role in forming an online community's descriptive norms by enabling users to show their appreciation, to encourage contributors and to highlighting pro-social behaviour. We also saw that women, in particular, were more receptive of the social feedback feature. In light of prior gender research, we discussed how this feature might promote women's engagement with Stack Overflow.

Chapter 6

Conclusions

In this thesis, we investigated gender differences in response to commonly used game elements on Q&A platforms and explored users' perceptions of a social feedback feature to highlight pro-social behaviour. In this chapter, we present a summary and our contributions. We conclude this thesis by describing promising directions for future research.

6.1   Summary and Contributions

This thesis presents our exploratory survey on gender differences in response to commonly used game features on Q&A platforms. In addition, we designed a social feedback feature to highlight pro-social behaviour as a complement to the current emphasis on content accuracy in the content-focused Q&A communities. Next, we designed and developed a prototype Q&A website to prompt users' reflections on the social feedback feature. We used this prototype to conduct an interview study to investigate users' perceptions of this feature, how they might use it, and how it might

affect their engagement with Stack Overflow. We showed that the Support feature was well-received by the participants and the women in particular. The women saw potential for the Support feature to make Online Q&A communities a safer space to post their questions. In light of prior work, we discussed the envisioned potential benefits of the Support feature for women and people with more collectivist attitudes.

This thesis contributes to the literature on gender differences in participation in online communities by highlighting the importance of values embedded in the game mechanisms. Our findings show the viability of highlighting pro-social behaviour through game features by incorporating peers' social feedback. This thesis opens up a path to explore how integrating different values into game features can be used to promote gender diversity.

6.2   Limitations and Future Research Directions

With our exploratory survey, we wanted to investigate gender differences in motivational orientations and responses to different game features. However, our limited sample size was an obstacle in gaining a more in-depth understanding of online Q&A community members' responses to game features. For example, we could not recruit more than four non-binary Stack Overflow or Stack Exchange users, which prevented us from comparing non-binary users with men and women. We could only find a few trends when comparing men and women, possibly due to our small sample size. In addition, we were interested in investigating motivational differences in different domains. However, we could not recruit enough participants who are exclusively a member of Gardening or Graphic Design Stack Exchange. Hence, further research

with more extensive recruitment of diverse participants is required to uncover comprehensive insights on how incentive mechanisms affect individuals with different gender identities in different domains.

Another limitation of our survey was the absence of attention check questions (i.e., instructional manipulation check) to ensure that participants read the instructions and questions carefully. Given the length of our questionnaire, we excluded participants who took less than 6.5 minutes to respond. However, we could more confidently identify and exclude inattentive participants by including attention check questions.

Our interview study has demonstrated positive initial reactions to adding social feedback on a Q&A; however, our participants had a short exposure to the introduced social feedback feature through interacting with a mock interface rather than experiencing a live community. Given that our findings suggest viability of the idea, further research is required to explore actual usage, potential behavioural changes, and long-term effects of such a feature. Further long-term studies such as field deployments would be necessary to see if and how users adopt the feature and change their behaviours (including seeing if it would lead to higher participation from women), eventually leading to changes in community norms. In addition, while we suspect that our Support feature is fairly unobtrusive and can easily be adapted to be suitable for other platforms, further research is needed to explore how members from other online communities might perceive its usefulness.

Social interactivity plays an important and positive role in women sharing knowledge online [9, 102–104]. Incorporating click-based social feedback is but one unob-

trusive approach that could potentially increase the social interactivity of a platform and make it less impersonal. More work is needed to explore different avenues for increased interactivity, such as creating sub-communities and leveraging personal connections [8]. In shaping these features, it will be important to consider how to balance the needs and perspectives of established and influential community members with those who are experiencing difficulty with the current norms.

We explored the views of men and women with different levels of experience with Stack Overflow to assess the perceptions of the social feedback feature; however, we admit incompleteness of our collected data in the sense of missing non-binary users' views. To design gender-inclusive features on knowledge-sharing Q&A platforms, further research regarding non-binary users' behaviour on these platforms, their motivation to participate, their response to different game features, and potential obstacles for their participation is required.

This thesis draws attention to some inclusivity considerations in employing game features on Q&A platforms. Stack Overflow Q&A community has been frequently criticized for being a harsh, unfriendly environment that deters women, newcomers, and other marginalized groups from getting engaged. However, Stack Overflow's gamified incentive system solely emphasizes content accuracy, and its potential role in creating a welcoming and diverse community seems to be disregarded. The game mechanisms should reflect what is valued in a community [87] and our findings suggest that they can potentially be used to encourage supportive behaviour.

In addition to the importance of values embedded in the game features, game balance plays a role in engaging diverse members. Game elements should be hard

enough to be interesting and easy enough to be feasible without being frustrating [105]. Prior work suggests that it is extremely difficult for some Stack Overflow members to compete with experts and gain reputation points which may disengage them from the game, but that in contrast, that some expert members of Stack Overflow complain about the lack of interesting and challenging questions to answer because the system rewards common, easier questions [57]. We speculate that game balance is an issue on Stack Overflow where there are not sufficiently challenging tasks for members from different levels of expertise. Having alternative reward systems that focus on other aspects of users' participation, for example, their attitude towards new users (e.g., providing answers that are comprehensible by beginners), might encourage a broader range of participants to engage with the platform and create a more welcoming community. Naturally, however, new reward systems will disrupt the current game balance and any direct concrete effects on the platform (such as additional privileges or badges) will need to be carefully investigated through longitudinal studies.

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Appendix A

TCPS 2: CORE – Certificate of Completion

PANEL ON RESEARCH ETHICS
Navigating the ethics of human research

TCPS 2: CORE

Certificate of Completion

This document certifies that

Mahya Maftouni

has completed the Tri-Council Policy Statement:
Ethical Conduct for Research Involving Humans
Course on Research Ethics (TCPS 2: CORE)

Date of Issue: **19 December, 2019**

Appendix B

The Survey Supplementary Information

B.1   Research Ethics Approval

University of Manitoba | Research Ethics and Compliance

Human Ethics - Fort Garry
208-194 Dafoe Road
Winnipeg, MB R3T 2N2
T: 204 474 8872
humanethics@umanitoba.ca

AMENDMENT APPROVAL

October 13, 2020

To: **Andrea Bunt**
              Principal Investigator

From: **Andrea Szwajcer, Chair**
              Joint-Faculty Research Ethics Board (JFREB)

Re: **Protocol # J2018:080 (HS22286)**
              Participating in Online Software Communities: The Role of Gender

---

Joint-Faculty Research Ethics Board (JFREB) has reviewed and approved your Amendment Request received on **September 28, 2020** to the above-noted protocol. JFREB is constituted and operates in accordance with the current *Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans.*

This approval is subject to the following conditions:

  i.   Approval is given for this amendment only. Any further changes to the protocol must be reported to the Human Ethics Coordinator in advance of implementation.

  ii.   Any deviations to the research or adverse events must be submitted to JFREB as soon as possible.

  iii.   Amendment Approvals do not change the protocol expiry date. Please refer to the original Protocol Approval or subsequent Renewal Approvals for the protocol expiry date.

A unit of the office of the Vice-President (Research and International)   **umanitoba.ca/research**

B.2 Recruitment Script

Faculty Investigator: Dr. Andrea Bunt (bunt@cs.umanitoba.ca)

We are currently conducting a study to understand how people interact on Stack Overflow or Gardening or Graphic Design Stack Exchange . Whether you are a poster or a reader, we are looking for people to share their experiences on these communities. Participation would consist of a survey that will take between 15 to 25 minutes.

To thank you for your participation, if you complete the survey and choose to provide your email address at the final question you will be entered into a draw for one of four $25 Amazon or Starbucks gift cards at your choosing (the approximate odds of being selected are 1 in 25). This research has been approved by the University of Manitoba Joint Faculty Research Ethics Board. If you have any concerns or complaints about this project you may contact any of the above-named persons or the Human Ethics Coordinator at 204-474-7122 or humanethics@umanitoba.ca.
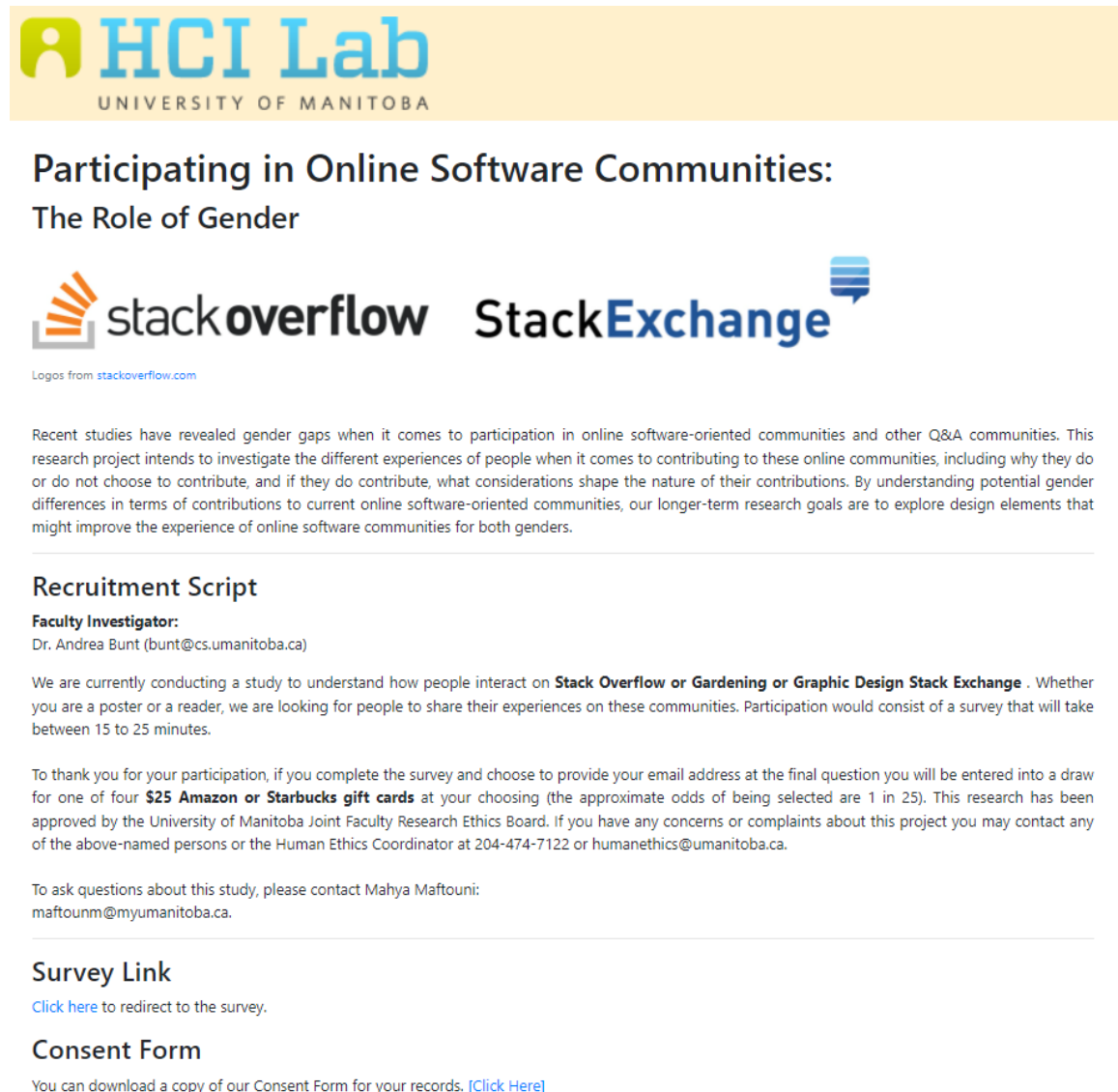
To ask questions about this study, please contact Mahya Maftouni:

maftounm@myumanitoba.ca.

B.3 Poster for Recruiting Participants

B.4   Recruitment Landing Page

Figure B.1: A screenshot of our recruitment landing page

B.5   Consent Form

DEPARTMENT OF COMPUTER SCIENCE

UNIVERSITY
OF MANITOBA

Winnipeg, Manitoba
Canada R3T 2N2
(204) 474-8313
FAX: (204) 474-7609

Research Project Title: Participating in Online Software Communities: The Role of Gender

Researchers:

Dr. Andrea Bunt, Associate Professor, Department of Computer Science, University of Manitoba, 204-474-8688, bunt@cs.umanitoba.ca

Mahya Maftouni, Master Student, Department of Computer Science, University of Manitoba, maftounm@myumanitoba.ca

Patrick Dubois, PhD Student, Department of Computer Science, University of Manitoba, umdubo26@myumanitoba.ca

Please take the time to read this carefully and to ensure you understand all the information.

This consent page should give you the basic idea of what this research is about and what your participation will involve. If you would like more detail about something mentioned here, or information not included here, you should feel free to contact Mahya Maftouni (maftounm@myumanitoba.ca).

You are being asked to participate in a survey on the topic of gender differences in motivation for participation in online communities. This survey is meant to be completed by anyone who has an account on Stack Overflow or Stack Exchange Gardening or Graphic Design sites. The researchers are interested in the motivational factors that influence someone's participation in an online community. Survey responses are anonymous. Risks to participating in this study are no greater than in everyday life. The direct benefits of this research are that participants who take part in the survey might have increased awareness of their own abilities to contribute to online communities. As a thank-you for your participation, if you provide your email address at the final question of the survey you will be entered into a draw for one of four $25 Amazon or Starbucks gift cards at your choosing (the approximate odds of being selected are 1 in 25). You must complete the survey to be eligible for the draw.

Participation in this study is voluntary. Completing the survey will take between 15 to 25 minutes. You can quit the survey at any time by closing this tab or window on your browser. If you quit without clicking the submit button at the end of the survey, none of your answers will be saved, so your data will not be used in the research. Once you complete the survey and press the submit button, you will no longer be able to withdraw from the study.

Data collected from the submitted survey will be retained indefinitely on password-protected and encrypted computers or USB keys, to which only researchers associated with this research have access. In addition, the University of Manitoba may look at research records to see that the research is being done in a safe and proper way. Results from this study will be submitted for review and publication to peer-reviewed academic journals and conferences (written and in the presentation). Once published, the results of this research will be made available to the public for free on the following webpage: hci.cs.umanitoba.ca. Again, no personal information about you will be included.

By clicking continue below, you indicate that you have understood to your satisfaction the information regarding participation in the research project and agree to participate by filling out the survey. In no way does this waive your legal rights nor release the researchers, sponsors, or involved institutions from their legal and professional responsibilities. You are free to withdraw from the study at any time, without prejudice or consequence by simply closing the browser tab or window. Your continued participation should be as informed as your initial consent, so you should feel free to ask for clarification or new information throughout your participation.

This research has been approved by the University of Manitoba Joint Faculty Research Ethics Board. If you have any concerns or complaints about this project you may contact any of the above-named persons or the Human Ethics Coordinator at 204-474-7122 or humanethics@umanitoba.ca.

B.6   Questionnaire

What is your age?

1. 18-24

2. 25-34

3. 35-44

4. 45-54

5. 55-64

6. 65 years or older

What is the highest degree or level of school you have completed?

1. Less than a high school diploma

2. High school degree or equivalent

3. Bachelor's degree (e.g. BA, BS)

4. Master's degree (e.g. MA, MS, MEd)

5. Doctorate degree (e.g. PhD, EdD)

6. Other (please specify)

What are your preferred pronouns?

1. He/His

2. She/Her

3. They/Their

In which Stack Exchange domains do you participate?

1. Gardening

2. Graphic design

3. Stack Overflow

What is your reputation score in your most active account among Stack Overflow, gardening Stack Exchange and graphic design Stack Exchange?

How long have you had your most active account among Stack Overflow, gardening Stack Exchange and graphic design Stack Exchange?

1. Less than 6 months

2. 6 months – 2 years

3. 2 years – 5 years

4. More than 5 years

Approximately how many questions have you ever posted on Stack Overflow, gardening Stack Exchange, or graphic design Stack Exchange?

1. 0

2. 1-5

3. 5-50

4. More than 50

Approximately how many answers have you ever posted on Stack Overflow, gardening Stack Exchange, or graphic design Stack Exchange?

1. 0

2. 1-5

    3. 5-50

    4. More than 50

How frequently do you visit Stack Overflow, gardening Stack Exchange, or graphic
    design Stack Exchange?

    1. Daily

    2. Weekly

    3. Monthly

    4. Few times a year

These items pertain to a series of hypothetical sketches. Each sketch describes an incident and lists three ways of responding to it. Please read each sketch, imagine yourself in that situation, and then consider each of the possible responses. Think of each response option in terms of how likely it is that you would respond that way. We all respond in a variety of ways to situations, and probably most or all responses are at least slightly likely for you.

If it is very unlikely that you would respond the way described in a given response, you should select answer 1 or 2. If it is moderately likely, you would select a number in the mid-range, and if it is very likely that you would respond as described, you would select answer 6 or 7.

1. You have been offered a new position in a company where you have worked for some time. The first question that is likely to come to mind is:

	1	2	3	4	5	6	7
What if I can't live up to the new responsibility?							
Will I make more at this position?							
I wonder if the new work will be interesting.							

2. You have a school-age child. On parents' night the teacher tells you that your child is doing poorly and doesn't seem involved in the work. You are likely to:

	1	2	3	4	5	6	7
Talk it over with your child to understand further what the problem is.							
Scold your child and hope they do better.							
Make sure your child does the assignments, because they should be working harder.							

3. You had a job interview several weeks ago. In the mail you received a form letter which states that the position has been filled. It is likely that you might think:

	1	2	3	4	5	6	7
It's not what you know, but who you know.							
I'm probably not good enough for the job.							
Somehow they didn't see my qualifications as matching their needs.							

4. You are a plant supervisor and have been charged with the task of allotting coffee breaks to three workers who cannot all break at once. You would likely handle this by:

	1	2	3	4	5	6	7
Telling the three workers the situation and having them work with you on the schedule.							
Simply assigning times that each can break to avoid any problems.							
Find out from someone in authority what to do or do what was done in the past.							

5. A close friend of yours has been moody lately, and a couple of times has become very angry with you over "nothing." You might:

	1	2	3	4	5	6	7
Share your observations with them and try to find out what is going on for them.							
Ignore it because there's not much you can do about it anyway.							
Tell them that you're willing to spend time together if and only if they make more effort to control themself.							

6. You have just received the results of a test you took, and you discovered that

you did very poorly. Your initial reaction is likely to be:

	1	2	3	4	5	6	7
"I can't do anything right," and feel sad.							
"I wonder how it is I did so poorly," and feel disappointed.							
"That stupid test doesn't show anything," and feel angry.							

7. You have been invited to a large party where you know very few people. As you look forward to the evening, you would likely expect that:

	1	2	3	4	5	6	7
You'll try to fit in with whatever is happening in order to have a good time and not look bad.							
You'll find some people with whom you can relate.							
You'll probably feel somewhat isolated and unnoticed.							

8. You are asked to plan a picnic for yourself and your fellow employees. Your style for approaching this project could most likely be characterized as:

	1	2	3	4	5	6	7
Take charge: that is, you would make most of the major decisions yourself.							
Follow precedent: you're not really up to the task so you'd do it the way it's been done before.							
Seek participation: get inputs from others who want to make them before you make the final plans.							

9. Recently a position opened up at your place of work that could have meant a promotion for you. However, a person you work with was offered the job rather

than you. In evaluating the situation, you're likely to think:

	1	2	3	4	5	6	7
You didn't really expect the job; you frequently get passed over.							
The other person probably "did the right things" politically to get the job.							
You would probably take a look at factors in your own performance that led you to be passed over.							

10. You are embarking on a new career. The most important consideration is likely to be:

	1	2	3	4	5	6	7
Whether you can do the work without getting in over your head.							
How interested you are in that kind of work.							
Whether there are good possibilities for advancement.							

11. A Person who works for you has generally done an adequate job. However, for the past two weeks their work has not been up to par and they appear to be less actively interested in their work. Your reaction is likely to be:

	1	2	3	4	5	6	7
Tell them that their work is below what is expected and that they should start working harder.							
Ask them about the problem and let them know you are available to help work it out.							
It's hard to know what to do to get them straightened out.							

12. Your company has promoted you to a position in a city far from your present location. As you think about the move you would probably:

	1	2	3	4	5	6	7
Feel interested in the new challenge and a little nervous at the same time.							
Feel excited about the higher status and salary that is involved.							
Feel stressed and anxious about the upcoming changes.							

The following questions relate to your reasons for participating in the online community. Different people have different reasons for participating in the online community, and we want to know how true each of these reasons is for you. There are three groups of items, and those in each group pertain to the sentence that begins that group. Please indicate how true each reason is for you using the following scale:

1	2	3	4	5	6	7
not at all true			**somewhat true**			**very true**

a) Why do I participate in this online community?

	1	2	3	4	5	6	7
Because I want the users to think I'm a good member.							
Because it's fun.							
Because I will feel bad about myself if I don't do it.							
Because I want to understand the subject							
Because I enjoy participating.							
Because it's important to me to participate.							

b) Why do I try to answer hard questions?

	1	2	3	4	5	6	7
Because I want the other members to think I'm smart.							
Because I feel ashamed of myself when I don't try.							
Because I enjoy answering hard questions.							
To find out if I'm right or wrong.							
Because it's fun to answer hard questions.							
Because it's important to me to try to answer hard questions in this community.							

c) Why do I try to do well in this community?

	1	2	3	4	5	6	7
So other users will think I'm a good member.							
Because I enjoy doing well in this community.							
Because I'll feel really bad about myself if I don't do well.							
Because it's important to me to try to do well in this community.							
Because I will feel really proud of myself if I do well.							

Please indicate how often you perform each action in this online community using the following scale.

1	**2**	**3**	**4**	**5**	**6**	**7**
always			**sometimes**			**never**

	1	2	3	4	5	6	7
How often do you update your profile?							
How often do you earn a badge?							
How often do you earn reputation points?							
How often do you interact with users' ranking and Top Users list?							
How often do you downvote or upvote posts?							
How often do you involve in the discussions in the comment section?							

Please indicate how important you believe it is for you to perform each action in this online community using the following scale.

| **1** | **2** | **3** | **4** | **5** | **6** | **7** |
| very important | | | | | | unimportant |

	1	2	3	4	5	6	7
How important is it to you to update your profile?							
How important is it to you to earn badges?							
How important is it to you to earn reputation points?							
How important is it to you to interact with users' ranking and Top Users list?							
How important is it to you to downvote or upvote posts?							
How important is it to you to be involved in the discussions in the comment section?							

Please indicate how strongly you agree or disagree with each of the following statements using the following scale.

| **1** | **2** | **3** | **4** | **5** | **6** | **7** |
| strongly agree | | | | | | strongly disagree |

	1	2	3	4	5	6	7
I feel like a competent person when I participate in this online community.							
I frequently feel like a very capable member in this online community.							
Most days I feel a sense of accomplishment in this online community.							
I think that I am pretty good when I visit this online community.							
I have been able to provide useful knowledge in this online community.							
I feel free to express my ideas and opinions in this online community.							
I feel I can be myself when I visit this online community.							
I feel free to visit this online community.							
I feel free from outside pressures when I am visiting this online community.							
When I visit this online community, I feel supported by other users.							
When I visit this online community, I feel that I am understood.							
The members of this online community are pretty friendly towards me.							
The members of this online community care about me.							
I frequently participate in knowledge-sharing activities in this online community.							
When participating in this virtual community, I usually actively share my knowledge with others.							

B.7 Assessment of Validity and Reliability of PLS-SEM

Here we present the assessment of validity and reliability of PLS-SEM for the path model analysis. First, I assessed the validity and reliability of reflective measurement models (Competence, Autonomy, Relatedness, and Knowledge sharing). I assessed convergent validity (Table B.1) through average variance extracted (AVE). Also, Discriminant validity was met as inter-correlation of the constructs do not exceed the square root of the AVE of either of compared constructs (Table B.2).

Table B.1: Validity and reliability of reflective measurement models

Variables	Items	Loading	Cronbach's α	CR	AVE
Knowledge Sharing	KS1	0.8892	0.7690	0.8962	0.8119
	KS2	0.9127			
Competence	C1	0.8698	0.7740	0.8689	0.6887
	C2	0.8085			
	C3	0.8099			
Autonomy	A1	0.8616	0.7422	0.8462	0.6484
	A2	0.8262			
	A3	0.7214			
Relatedness	R1	0.7548	0.7672	0.8620	0.6764
	R2	0.8198			
	R3	0.8873			
	R4	Omitted			

Table B.2: Discriminant validity (The diagonal means the square root of AVE.)

	Knowledge Sharing	Competence	Autonomy	Relatedness
Knowledge Sharing	(0.9010)			
Competence	0.7935	(0.8299)		
Autonomy	0.4269	0.5137	(0.8052)	
Relatedness	0.5167	0.6083	0.7110	(0.8224)

Appendix C

Iterations on Interface Design
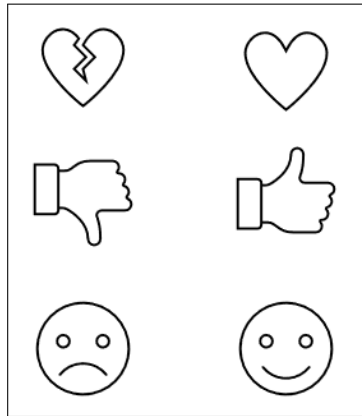
Figure C.1: Sample of icons that I considered for the additional social feedback
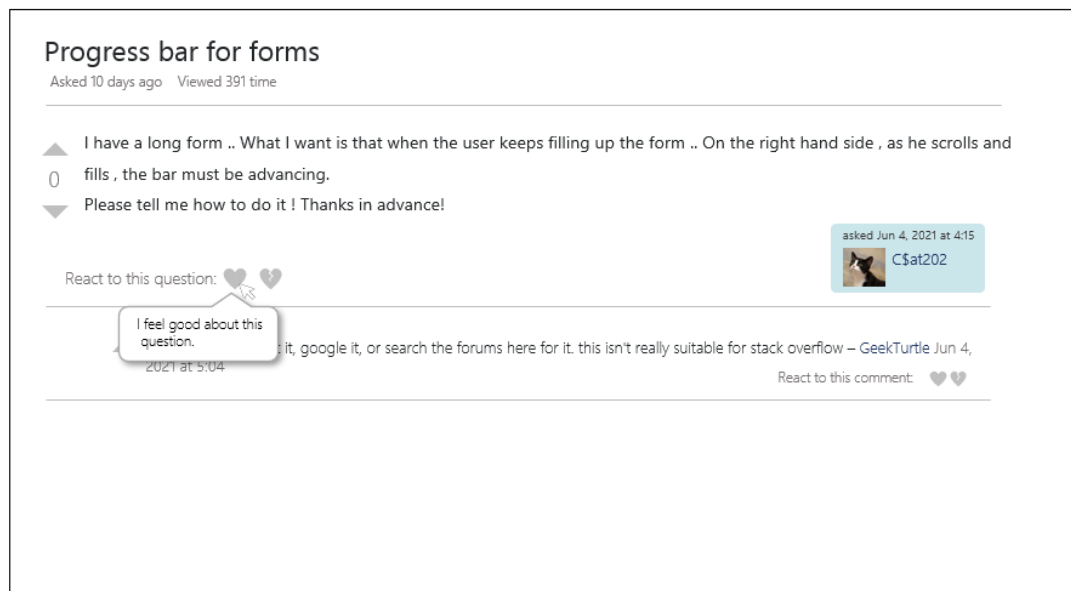
Figure C.2: Sample of an early version of the prototype

Appendix D

The Interview Study

Supplementary Information

D.1 Research Ethics Approval

University of Manitoba | **Research Ethics and Compliance**

Human Ethics - Fort Garry
208-194 Dafoe Road
Winnipeg, MB R3T 2N2
T: 204 474 8872
humanethics@umanitoba.ca

AMENDMENT APPROVAL

June 21, 2021

To: **Andrea Bunt**
             Principal Investigator

From: **Andrea Szwajcer, Chair**
             Research Ethics Board 2 (REB 2)

Re: **Protocol # J2018:080 (HS22286)**
             Participating in Online Software Communities: The Role of Gender

Research Ethics Board 2 (REB 2) has reviewed and approved your Amendment Request received on **June 16, 2021** regarding the above-noted protocol.

REB 2 is constituted and operates in accordance with the current *Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans – TCPS 2 (2018)*.
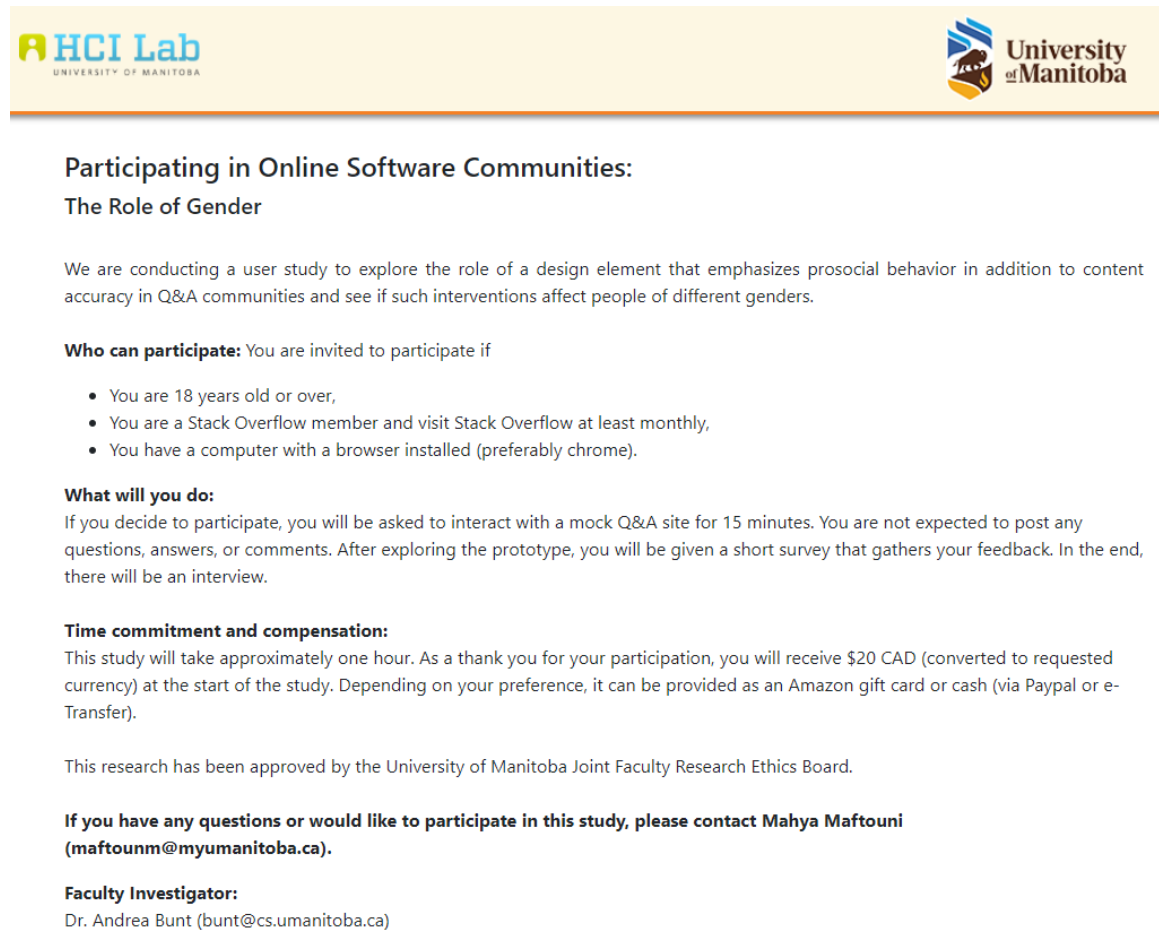
This approval is subject to the following conditions:

    i.   Approval is granted for this amendment only.

    ii.   Any further changes to this research requires subsequent amendment approvals from the Human Ethics Office before implementation.

    iii. Any deviations to the research or adverse events must be reported to the Human Ethics Office immediately.

    iv. Amendment Approvals do not change the protocol expiry date. Please refer to the original Protocol Approval or subsequent Renewal Approvals for the protocol expiry date.

D.2   Screening Questionnaire

1. What is your gender identity?

2. Are your 18 years old or over?

3. Do you have a Stack Overflow account?

4. On average, how frequently do you visit Stack Overflow?

   - Daily

   - Weekly

   - Monthly

   - A few times a year

5. How long have you had your Stack Overflow account?

   - Less than 6 months

   - 6 months – 2 years

   - More than 2 years – 5 years

   - More than 5 years

D.3   Recruitment Landing Page

Participating in Online Software Communities:
The Role of Gender

We are conducting a user study to explore the role of a design element that emphasizes prosocial behavior in addition to content accuracy in Q&A communities and see if such interventions affect people of different genders.

Who can participate: You are invited to participate if

- You are 18 years old or over,
- You are a Stack Overflow member and visit Stack Overflow at least monthly,
- You have a computer with a browser installed (preferably chrome).

What will you do:
If you decide to participate, you will be asked to interact with a mock Q&A site for 15 minutes. You are not expected to post any questions, answers, or comments. After exploring the prototype, you will be given a short survey that gathers your feedback. In the end, there will be an interview.

Time commitment and compensation:
This study will take approximately one hour. As a thank you for your participation, you will receive $20 CAD (converted to requested currency) at the start of the study. Depending on your preference, it can be provided as an Amazon gift card or cash (via Paypal or e-Transfer).

This research has been approved by the University of Manitoba Joint Faculty Research Ethics Board.

If you have any questions or would like to participate in this study, please contact Mahya Maftouni (maftounm@myumanitoba.ca).

Faculty Investigator:
Dr. Andrea Bunt (bunt@cs.umanitoba.ca)

Figure D.1: A screenshot of our recruitment landing page

D.4   Consent Form

University of Manitoba | Department of Computer Science
Faculty of Science

Research Project Title: Participating in Online Software Communities: The Role of Gender

Researchers:

Dr. Andrea Bunt, Professor, Department of Computer Science, University of Manitoba, 204- 474-8688, bunt@cs.umanitoba.ca

Mahya Maftouni, Master Student, Department of Computer Science, University of Manitoba, maftounm@myumanitoba.ca

Patrick Dubois, PhD Student, Department of Computer Science, University of Manitoba, umdubo26@myumanitoba.ca

Please take the time to read this carefully and to ensure you understand all the information.

This consent page should give you the basic idea of what this research is about and what your participation will involve. If you would like more detail about something mentioned here, or information not included here, you should feel free to contact Mahya Maftouni (maftounm@myumanitoba.ca).

You are being asked to participate in a research study on the topic of gender differences in participation in online communities. The goal is to explore the role of community dynamics that emphasis pro-social behaviour in addition to purely emphasizing content accuracy. To explore this concept, we have developed prototype interfaces (i.e., interface mock-ups) of a Q&A website. You have around 15 minutes to explore the prototype. After interacting with the prototype, you will complete a short questionnaire and participate in a semi-structured interview about your participation, usage, and opinion of the prototype. If you have any questions or concerns at any time during your participation, please feel free to ask the researcher for clarification.

Risks to participating in this study are no greater than in everyday life. The direct benefit of this research is that participants who take part in the study might have increased awareness of their own abilities to contribute to online communities. As a thank-you for your participation, you will receive a $20 (Canadian dollars) compensation in the form of cash or a gift card (at your choosing) after signing the consent form. You are free to withdraw from the study any time up to the end of the study and/or refrain from answering any questions you prefer to omit. Even by withdrawing, you will keep your compensation. Participation in this study is voluntary. Completing the study will take between 60-90 minutes.

We wish to record our discussions. Audio will be recorded on the researcher's password protected computer using a third-party software (e.g., Audacity) that stores the files locally on the same computer. The audio recording will assist our data analysis by allowing us to review the discussion and the study session in detail. Any information you choose to contribute in our discussion is completely confidential and will be used for anonymized research analysis. We may use anonymized quotes for purposes of dissemination with general gender descriptions (e.g., M=Man, W=Woman, NB=Non-Binary). Your name will not be included or in any other way associated with the data presented in the result of this study. We will also collect any interaction data from your usage of the prototype.

By signing this consent form, you agree that you understand this and that we may use the recorded audio and prototype usage logs for data analysis purposes only. You may freely withdraw from the study if you do not consent to the collection of any of this data.

Data collected from this study will be retained indefinitely on password-protected and encrypted computers or USB keys, to which only researchers associated with this research have access. In addition, the University of Manitoba may look at research records to see that the research is being done in a safe and proper way. Results from this study will be submitted for review and publication to peer-reviewed academic journals and conferences (written and in the presentation). Once published, the results of this research will be made available to the public for free on the following webpage: hci.cs.umanitoba.ca. Again, no personal information about you will be included.

By signing this form, you indicate that you have understood to your satisfaction the information regarding participation in the research project and agree to participate. By doing this, you also confirm that you are of the age of majority in Canada (18 years or more). In no way does this waive your legal rights nor release the researchers, sponsors, or involved institutions from their legal and professional responsibilities. You are free to withdraw from the study at any point during this session, without prejudice or consequence. If you do not request a transcript, withdrawal will not be possible after the end of your interview. Withdrawal is possible until the transcript is ready for review if you request one. If a transcript is requested, you may withdraw within one week of receiving the transcript, or the most recent communication from the researcher if changes are requested, by emailing the researcher. Following this period withdrawal will not be possible. Your continued participation should be as informed as your initial consent, so you should feel free to ask for clarification or new information throughout your participation.

This research has been approved by the University of Manitoba Joint Faculty Research Ethics Board. If you have any concerns or complaints about this project, you may contact any of the above-named persons or the Human Ethics Coordinator at 204-474-7122 or humanethics@umanitoba.ca.

A copy of this consent form has been given to you to keep for your records and reference.

☐ I wish to receive a summary of the findings.

☐ I wish to receive a copy of the transcript of the audio recording to confirm its accuracy. Transcripts will be sent within three weeks of the interview. You may withdraw within one week of receiving the transcript or the most recent communication from the researcher by emailing the above-named persons. Following this period, withdrawal will not be possible.

Please write your email address if you checked a box above:

Participant's email address: ————————————————

Participant's signature: ————————— Date: —————

Researcher's signature: ————————— Date: —————

D.5   Prototype Screenshots
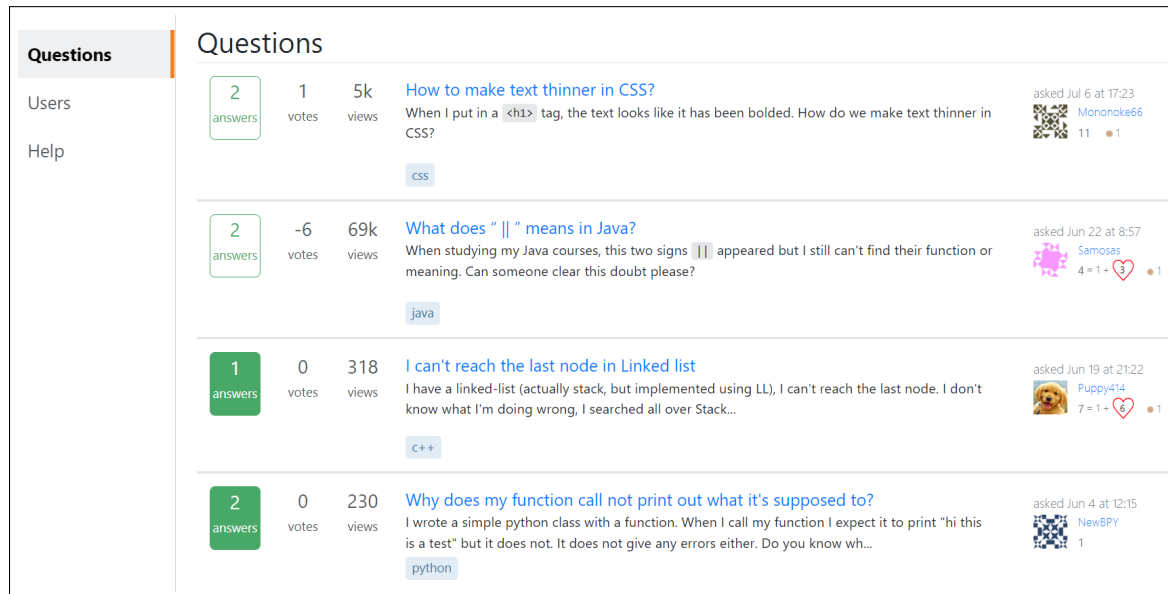
Figure D.2: The prototype's home page

Figure D.3: Sample user profile page from the prototype

D.6   Semi-Structured Interview Sample Questions

1. What is your reaction to the interface? Feel free to talk about anything you want.

2. What do you think about the new Support buttons? What did you like/dislike about them? How do you feel about using Support buttons?

3. If Stack Overflow implements the Support feature, how likely is it for you to use them? Why?

4. In what cases have you used the Support button, or you can imagine you might use it? Do you see any differences between the Support and down/up-votes?

5. How would you feel about receiving "Support" from fellow community members?

6. How do you feel about changing reputations based on the Support-vote?

7. How do you feel about ordering the answers based on the number of Support they received in addition to votes?

8. How do you think Stack Overflow members will feel about the Support feature?

9. How do you think implementing the Support feature might affect Stack Overflow?

10. Are there any other comments you would like to add?