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Gender Influence on Communication Initiated within Student Teams

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ABSTRACT

Collaboration is important during software development, but related work has found gender differences can influence the collaboration process, creating inequality in the team's dynamics. In this paper, we present a gender analysis study that involved 39 students, examining their teams' online collaborations while contributing to a large open-source software project. Eight teams of 4-6 Software Engineering (SE) students communicated over an online messaging platform, Slack, to complete an eight-week project. The goal of this study is to identify gender differences emerging from team collaboration. A mixed-methods approach was used to collect students' teamwork experiences and analyse their collaboration. Our research shows statistically significant results in female students' leadership, coordination, and project-monitoring behaviours used to complete the project. The results also showed a higher rate of help seeking within the all-female team, an infrequent behaviour observed in the all-male and mixed-gender teams. Our findings raise future research opportunities to further investigate the gender differences emerging from team collaboration.

CCS CONCEPTS

• **Software and its engineering**; • **Social and professional topics → Gender**; • **Human-centered computing** → *Collaborative and social computing*;

KEYWORDS

Gender Analysis, Teamwork, Collaboration

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1 INTRODUCTION

Software development is a collaborative process that involves people working together to create software applications and services [42]. Collaboration involves conflict resolution, decision making, problem solving, and communication skills [41]. When students collaborate on assessments through teamwork, poor communication might arise, potentially influencing how they work together [38]. Poor communication could be the result of biases that consciously or unconsciously influence a student's behaviour [40]. For example, gender bias can contribute to the barriers that female contributors experience while collaborating on software projects [18].

Through the lens of gender, we performed a study that examined the gender differences when student teams contribute to a large open-source software project. The goal of this study is to identify gender differences that may occur while students collaborate on a project. By performing gender analysis on students' online communications, we attempt to answer the following research question:

- *RQ1: How is gender influence communication initiated within student teams?*

To answer this question, our study examined the communications of 39 students working in eight teams of 4-6 Software Engineering (SE) students communicating over Slack [32], an online messaging platform. A mixed-methods approach was used to analyse the data collected from an eight-week project. The study used gender analysis "to assess differences in participation, benefits and impacts between males and females, including progress towards gender equality and changes in gender relations" [16, p. 100]. Pre-post surveys were used to collect students' perceptions on teamwork; we then analysed their online communications, to identify their teamwork behaviours. The results from this study showed significant statistical results pertaining to female students initiating communication, engaging team leadership, and performing project coordination and monitoring necessary to complete the project. The study also showed more help seeking from peers within the all-female team. Help seeking was an infrequent behaviour within the all-male and mixed-gender teams. Our findings raise future research opportunities to further investigate and mitigate gender differences observed in this study.

2 BACKGROUND AND RELATED WORK

It is well established that women are under-represented in the computing disciplines. Statistics from 2016 show that in the United States, 19% of the CS Bachelor's degrees were awarded to women, a recorded decline from the 27% awarded in 1997 [24]. The computing fields have examined retention strategies to increase women's representation [4]. Within education, retention strategies are necessary because female students sometimes change their computing majors after their first year due to waning interests [20]. Changing majors is sometimes the result of low self-confidence, where they

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perceive men are better in computing [20]. To better understand gendered factors that potentially influence the retention of female students in computing, we surveyed literature performing gender analysis on collaborative learning in the computing disciplines.

Collaborative learning is an approach that has students working together to better understand learning concepts [41]. Collaborative learning also helps students develop teamwork skills for professional careers [25]. During collaborative learning, challenges, such as social pressures, might lead to conflicts that can interfere with learning [17]. Social pressures could be gender related, resulting in inequitable division of labour within mixed-gender teams [9]. A study conducted by Cox and Fisher [6] surveyed female SE students working together in an all-female team, to compare with their prior experiences in mixed-gender teams. The results showed higher levels of cooperation in the all-female team, where they encouraged each other to attempt new tasks. One female student described a non-inclusive environment within the mixed-gender teams, noting that male students "don't allow the girl(s) in a group to fully participate" [6, p. 8]. In another study by Wang and Redmiles [40], *intergroup contact theory* was applied to collaborative learning. Intergroup contact theory attempts to counteract bias by bringing different social groups, such as women and men, together for interpersonal interactions [26]. The goal of this study was to reduce implicit gender bias, the preferential treatment towards one gender over another [23]. In this study, 280 SE students formed 70 mixed-gender teams to collaborate on an eight-week software project. To evaluate whether intergroup contact theory had any influence, participants were given pre-post assessments to measure changes in their implicit gender bias. The results showed a reduction in male students' implicit gender bias when they collaborated in a predominately female mixed-gender team. However, these changes were not apparent in female students' implicit gender bias while collaborating in a predominately male mixed-gender team.

During collaborative learning, activities such as student questioning can give students the opportunity to learn from peers [2], and can help reduce misconceptions on concepts [5]. However, social barriers sometimes hinder students from asking questions, because they do not want to appear "ignorant" [14] to their peers. A study conducted by Sankar et al. [30] evaluated the questions and answers of more than a million STEM students on a Q&A forum, Piazza, to examine female students' feelings of isolation during the learning process. Female students were less involved in answering questions, and used the Piazza's anonymity feature more than male students. The results suggest female students might feel more confident contributing to questioning activities, but only anonymously, which helps them feel less isolated in their learning. A later Piazza study [36] evaluated gender differences in students' engagement on the forum. This study collected the data of 2500 Piazza users, analysing the questioning frequency and length of engagement. The results confirmed that female students use the anonymity feature more, which enables them to asked more questions and spend more time on the forum. These studies suggest female students have apprehension contributing during collaborative learning, but strategies such as anonymity could help them feel less isolated and give them confidence to contribute.

The surveyed work highlights gender differences during collaborative learning. Gender analysis was performed through surveys and textual analysis, identifying the differences and applying treatments to minimise challenges female students might experience during collaborative learning. We build on the related work, where we examine how gender differences manifest when students collaborate on software projects. To the best of our knowledge, our work is the first attempt at examining initiated communication within student teams, identifying gender differences that emerge from the collaboration process.

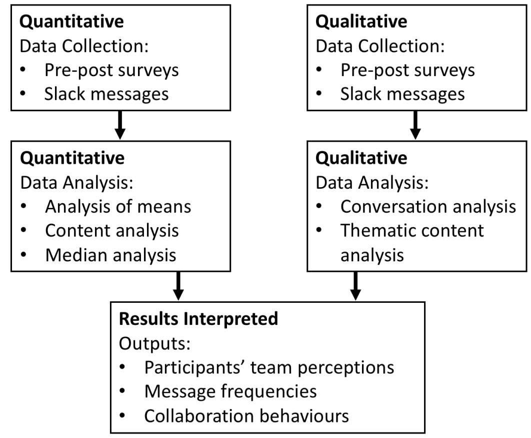


Figure 1: Diagram of Study Method (Adapted from [8])

3 STUDY METHOD

We adopted a mixed-methods approach [7] using a triangulation design [8] that interprets the collected data. Figure 1 shows the parallel consideration given to the quantitative and qualitative data sources. The quantitative method interprets the data from the pre-post surveys and the Slack messages, while the qualitative method provides an in-depth view into the students' communications.

3.1 Context

The study was conducted in a 12-week SE course (Semester 1 2021) at the University of Adelaide, teaching best practices in software development. The course had 79 enrolled students, 14 (18.00%) female and 65 (82.00%) male. The enrolled students were a blend of under- (55.70%, n=44) and postgraduate (45.30%, n=35) students.

To reinforce learning objectives, this course had students working in teams to contribute to a large open-source software project hosted on GitHub. Four different open-source projects, external to the university, were part of the course. Student teams selected one of the projects to work on. The lecturer notified the four project owners that students would be contributing to their projects, submitting code review requests, and asking questions. The lecturer asked the project owners to respond to students' code reviews and questions in a timely and polite fashion. The lecturer provided guidance on the project's requirements, but did not assign team roles. Teams received unique issues to solve in the open-source project so that there was no overlap in teams' contributions. Teams were given eight weeks to complete the project, which had two milestones: a project proposal and a final presentation. The presentations were given by the teams on the eighth week of the project. During the presentation, teams explained their results and experiences collaborating on the open-source project.

A project requirement was the application of online team communication. The communication was worth 20% of the project's grade. The lecturer decided to use Slack [32] for the online communication, to give students real-world experiences using tools that support professional software development [19]. Slack channels were created for each team on the university's workspace, a meta-container that stores and manages channels. Channels are private spaces for teams to communicate. Each channel was labeled with the team IDs, such as Team-1. Students were instructed by the lecturer to use their Slack channels for team collaboration, providing guidance that included the use of polite and responsive communication for effective collaboration. The lecturer also explained that the Slack messages should be meaningful so that someone outside their team could comprehend their actions through the messages.

Students from the course were invited to participate in the study. Ethical approval was obtained from the university's ethics committee to conduct the study. To recruit volunteers, an announcement was made by the main author during a class session and posted on Canvas, the Learning Management System (LMS) used by the university to administer the course and instructional materials. Students who participated in the study received an USD$60 voucher.

3.2 Pre-Post Surveys

The pre-post surveys[1] were designed to collect participants' teamwork experiences. The surveys were constructed from previous instruments that measured gender bias [11], gender inequality [27], and team collaboration [35]. We adjusted the questions from these instruments to frame the questions from the student's perspective.

The pre-survey required students to provide their full name and gender, providing the options *Female*, *Male*, *Prefer not to say*, and *Prefer to self-describe*. Four Likert scale questions asked about collaboration experiences and prior exposure to gender bias and inequality. For example, *Have you experienced gender bias in the School of Computer Science*, and *I am mindful of my communication approach in the classroom*. Three questions were open-text, giving students the opportunity to explain the prior collaboration experiences, such as *What is your level of satisfaction with the group in your last project?* The post-survey asked similar questions to the pre-survey, but re-framed within the teamwork conducted in the study. For example, *Did you experience gender bias while working on the project?* The one open-text question presented in the post-survey asked participants to elaborate on their teamwork experiences.

The surveys were administered over Google Forms. The pre-survey was distributed the first week the teams were formed, while the post-survey was administered in the last week of the project. Participants were given a week to complete the surveys. Afterwards, the survey responses were exported from Google Forms for analysis.

4 DATA ANALYSIS

4.1 Quantitative Analysis

Analysis of means (ANOM) was applied to the pre-post survey responses to analyse participants' collaboration experiences and to compare responses by gender, to determine how the genders perceived team collaboration. The Mann-Whitney U Test [15] was used to identify any statistical differences within the pre-post surveys, and to compare the participants' changed perceptions after collaborating on the open-source project. The median was calculated on students' prior involvement in software projects. To calculate the median on the pre-survey open-text responses, the data was first numerically quantified, for example, *"six"* to *6*. SPSS Statistics was used to perform the all the statistical analysis reported in this paper.

Quantitative content analysis (QCA), an approach for analysing textual language in articles and transcripts [28], was applied to the Slack messages for an overview of students' communication. To perform QCA, the communication history from the teams' Slack channels were extracted using the Slack API[2]. The history was saved as text files organised by team. QCA was used to generate Slack message frequencies, presenting message frequencies by team and gender. Two Python tools were constructed to perform QCA on the teams' Slack messages. The first tool was a pre-processing tool that converted the multi-line messages to one line, allowing us to quantify the participants' Slack messages. The single lines contained the participants' ID, the date the message was sent, and the message content. The second tool aggregated the participants' messages, to import into a spreadsheet to quantify the results. Within the spreadsheet, message frequencies were quantified by individual team and by gender across the teams. To validate the two tools, a small dataset was manually constructed by the authors using the first 50 Slack messages generated by Team-1. The dataset was used during the implementation and testing of the QCA tools, to confirm the tools were working as expected.

4.2 Qualitative Analysis

Thematic content analysis [21] was performed on the open-text pre-post survey questions related to students' teamwork satisfaction. NVivo was used to code the responses, creating new nodes for emerging satisfaction levels. The coding formed a matrix representing students' overall satisfaction with their teamwork experiences.

Student7.1:	Hi @Student7.4, were you able to push the changes in git already? ☺
Student7.4:	I did, did the push not go through? ...
Student7.1:	oh i was waiting for confirmation. I'll check it thanks

Figure 2: Example of Sequence Organisation

Qualitative analysis also provided an in-depth examination of the teams' online communications. Conversation analysis (CA) [29], previously used to examine the context of the online asynchronous communications [22], was used to evaluate the participants' Slack messages. CA analyses communication through *turn-taking*, where a turn is an action a participant takes when contributing to a conversation. Successive turns create a *sequence organisation*, where a sequence is an ordered series of events for a common action [31]. Figure 2 shows an example of a sequence, where a student is enquiring about an outstanding task from a team member. Sometimes there are *disruptions* in the sequences. Disruptions are turns

[1]https://doi.org/10.6084/m9.figshare.16715593

[2]https://api.slack.com/apis

associated with another sequence, and are common in online asynchronous communications because of the overlap during message construction [13].

Behaviour	Definition
Initial Codes Based on [39, p. 108]	
Backup Behaviour*	Assists team members to help complete project tasks and processes.
Communication	Elicits information from peers and responds to their plans and goal-setting.
Coordination	Reports on the learning activities and processes.
Feedback**	Gives, seeks, and receives information from peers on their contributions to the project.
Monitoring	Monitors team's processes, progress, and activities.
Team Leadership	Restates problem, initiates team planning, identifies items that need to be addressed.
Team Orientation	Communicates socially or the communication is a function of social communication.
Emerging Codes	
Discussing Final Milestone	Works towards the completion of a presentation that serves as the final project milestone.
Scheduling Meeting	Organises and arranges a face-to-face or online team meeting.

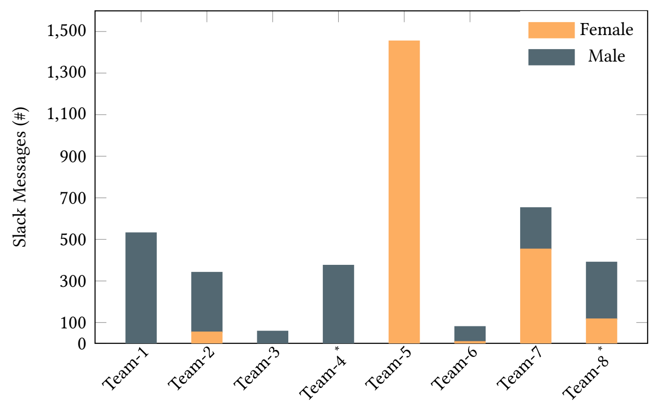
Table 1: Coding Framework for Conversation Analysis

* Subcomponents: seeking and supporting team members.
** Subcomponents: giving, receiving, and seeking feedback.

We used the twofold conversation analysis process outlined by Woodruff and Aoki [43] to interpret the teams' communications. The first step identified the sequences through their *opening sequences*, such as a greeting or topic initiation that resets the communication. We classified a disruption as an opening sequence if it did not relate to an existing sequence. In the second step, we coded the sequences using NVivo, to determine students' motivations for initiating sequences. The initial coding framework, previously used to analyse CS students' teamwork behaviours during online team activities [39], was established using the Dickinson and McIntyre [10] teamwork model, with refinements by Vivian et al. [39] to include role behaviours. Table 1 shows the model's seven behaviours and two codes emerging from the coding process. The table also shows the definitions for each behaviour. Sequences were assigned a behaviour node and a node to identify the student initiating the sequence that contained their gender and de-identified ID for anonymity. For example, the sequence presented in Figure 2 would be assigned the *Monitoring* node and *Student7.1* node, representing a female student in Team-7.

The inter-rater reliability metric was used to ensure consistency in the rating system. At the start of the coding process, the authors discussed and agreed upon the coding protocol using Team-1 sequences as the basis for the protocol discussion. The decision to code against the *Backup Behaviour* or *Feedback* node was based on the completion of the task or process discussed in the sequence. Discussions on completed tasks or processes were assigned *Feedback*, while in-progress work was assigned *Backup Behaviour*. The authors decided to create two emerging nodes, shown in Table 1, for meetings and the final milestone because these were specific themes frequently raised in the teams' communications, and we wanted to identify themes that were of strong interest to the students. The authors also decided that sequences focusing on a common goal would be assigned to the same node. For example, sequences related to arranging or attending meetings were assigned the same node, *Scheduling Meeting*. To validate the coding protocol, three authors coded the sequences for Team-1, resulting in 87% agreement, an acceptable agreement rate [33]. When coding for all teams was completed, the coded framework was extracted from NVivo as a matrix, to identify the teamwork behaviours. The data from the coded framework further triangulated findings from the survey responses and quantitative analysis of the Slack messages.

5 RESULTS



Team-1		Team-2		Team-3		Team-4*	
Female	Male	Female	Male	Female	Male	Female	Male
0	5	1	4	0	6	0	4

Team-5		Team-6		Team-7		Team-8*	
Female	Male	Female	Male	Female	Male	Female	Male
4	0	1	5	2	3	1	3

Figure 3: Team Composition and Message Frequency
*** Has a non-participant team member; excluded from study**

Eight (53.33%) out of 15 teams volunteered for the study. There were 39 (49.37%) participants: nine female (23.08%) and 30 male (76.92%) students. Most (64.29%) of the enrolled female students participated in the study. Figure 3 shows the gender composition for the eight teams, containing one all-female, three all-male, and four mixed-gender teams. Teams 4 and 8 each had a team member that did not volunteer for the study, so these team members' Slack communications were excluded from the study. The majority (75%, n=6) of the teams were formed by the students, except for Teams 1 and 4, where the lecturer randomly assigned students, because the teams needed additional members. The volunteers had prior teamwork experience (median 5 team projects).

The Mann-Whitney U Tests (p<0.05 two-tailed) showed no significant differences between the female and male participants' survey responses. The majority (92.31%, n=36) of the participants recalled positive experiences in their past projects. Seven (17.95%, Female=2,

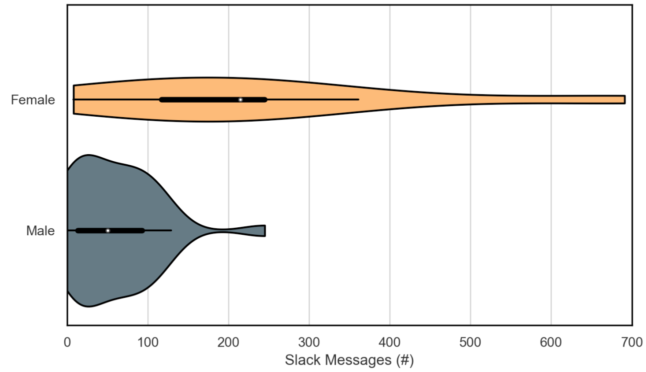


Figure 4: Slack Message Frequency by Gender

Male=5) participants had previously experienced gender bias, 21 (53.85%, Female=6, Male=15) had not, while 11 (28.20%, Female=1, Male=10) were unsure. For the teamwork conducted during the study, the majority (66.67%, n=26) of the participants were satisfied in their experiences. Almost all participants (97.44%, n=38) also felt included in their teams.

Figure 3 presents the message frequency for each team, grouping the messages by gender. The figure shows that the all-female team, Team-5, generated the most (37.46%, f=1454) messages. Figure 4 also shows the female participants generating more messages, where nine female participants generated more messages (2086 messages, $\bar{x}$=231.78) than the 30 male participants (1795 messages, $\bar{x}$=64.11). The figures showed all the female participants communicating with their team, while two male students did not.

The results from the conversation analysis identified eight teamwork behaviours, shown in Table 2. The table arranges the behaviours by frequency, and shows the teams' application of the behaviours. The bar graphs illustrate the gender initiating the behaviours. The bottom row in the table represents the total behaviours generated by each team. Table 2 shows eight behaviours, six from the initial coding framework and two emerging: *Scheduling Meeting* (16.58%) and *Discussing Final Milestone* (10.16%). The behaviours within *Scheduling Meeting* closely relate to *Team Leadership*, while those in *Discussing Final Milestone* have attributes of *Communication*, *Coordination*, and *Team Leadership* behaviours.

The most frequent behaviour was *Communication* (33.16%), for example, *"just noting down our preferred issues." Team Orientation* (3.74%), for example, *"Girls, my laptop died"*, was rarely applied by the teams. Though unrelated to project development, *Team*

			All-Female		All-Male		Mixed-Gender			
Behaviour (χ^2, p-value)	**Total** (%)	**Total** (f)	**Team-5** F=4	**Team-4** M=4	**Team-1** M=5	**Team-3** M=6	**Team-7** F=2, M=3	**Team-8** F=1, M=3	**Team-2** F=1, M=4	**Team-6** F=1, M=5
Communication χ^2=1.688, p=0.4230	33.16%	f=124 0.43 0.57	f=32 1.0	f=15 1.0	f=12 1.0	f=5 1.0	f=28 0.64 0.36	f=13 0.15 0.85	f=17 0.06 0.94	f=2 0.0 1.0
Scheduling Meeting χ^2=0.501, p=0.7784	16.58%	f=62 0.48 0.52	f=17 1.0	f=11 1.0	f=6 1.0	f=2 1.0	f=14 0.71 0.29	f=3 0.67 0.33	f=6 0.17 0.83	f=3 0.0 1.0
Team Leadership* χ^2=14.199, p=0.0008	12.57%	f=47 0.83 0.17	f=15 1.0	f=1 1.0	f=1 1.0	f=1 1.0	f=21 1.0 0.0	f=3 1.0 0.0	f=5 0.0 1.0	f=0
Coordination* χ^2=8.598, p=0.0136	12.03%	f=45 0.53 0.47	f=12 1.0	f=5 1.0	f=2 1.0	f=2 1.0	f=10 0.80 0.20	f=10 0.30 0.70	f=3 0.0 1.0	f=1 1.0 0.0
Discussing Final Milestone χ^2=1.981, p=0.3714	10.16%	f=38 0.47 0.53	f=11 1.0	f=5 1.0	f=3 1.0	f=3 1.0	f=6 0.83 0.17	f=6 0.33 0.67	f=4 0.0 1.0	f=0
Monitoring* χ^2=21.277, p=0.00002	6.15%	f=23 0.70 0.30	f=9 1.0	f=1 1.0	f=5 1.0	f=0	f=6 1.0 0.0	f=2 0.50 0.50	f=0	f=0
Backup Behaviour: Seeking* χ^2=8.547, p=0.0139	5.61%	f=21 0.71 0.29	f=13 1.0	f=2 1.0	f=1 1.0	f=0	f=3 0.33 0.67	f=1 0.0 1.0	f=1 1.0 0.0	f=0
Team Orientation χ^2=3.009, p=0.2221	3.74%	f=14 0.64 0.36	f=9 1.0	f=1 1.0	f=0	f=0	f=0	f=2 0.0 1.0	f=2 0.0 1.0	f=0
Total Behaviours by Teams (%)		f=374 0.54 0.46	f=118 31.55% 1.0	f=41 10.96% 1.0	f=30 8.02% 1.0	f=13 3.48% 1.0	f=88 23.53% 0.78 0.22	f=40 10.70% 0.28 0.72	f=38 10.16% 0.08 0.92	f=6 1.60% 0.17 0.83

Table 2: Coding Framework - Initiated Teamwork Behaviours Organised by Frequency (Female Male)

* Statistically significant differences ($\chi^2 \geq 7$ at $p \leq 0.05$) between female and male students' initiated behaviours

Orientation provides team cohesion through social communication [10]. The sparse application of *Team Orientation* is supported by previous findings [1] that show students rarely engage in social interactions during online teamwork.

Pearson's chi-squared test (χ^2) was applied to the results, comparing the behaviours by female to male students. The chi-squared tests showed statistical differences, where $\chi^2 \geq 7$ is significant at $p \leq 0.05$ for four behaviours: *Team Leadership*, *Monitoring*, *Coordination*, and *Backup Behaviour: Seeking*. A reason for the statistical difference is that these four behaviours were predominately initiated by female students. *Team Leadership* (12.57%, f=47) provided direction for the team, *Monitoring* (6.15%, f=23) showed team members asking their peers for updates on their tasks, and *Coordination* (12.03%, f=45) involved team members asking their peers to perform tasks, such as *"@Student7.2, please help perform another round of QAT (quality assurance testing)"*. *Backup Behaviour: Seeking* (5.61%, f=21) showed a team member asking for help from peers on their tasks. For example, *"@Student5.3 could you help me with my error"*.

The results from this study show gender differences in the initiated teamwork behaviours. In the absence of defining team members' roles, female students initiated more behaviours related to leadership, coordination, and project monitoring to help their teams complete the project. Though these teamwork behaviours were championed by male students in all-male teams, shown in Team-4, the application of these behaviours was infrequent compared to the female students' application of these behaviours. In addition, the backup behaviour of help seeking was primarily initiated by members of the all-female team.

6 THREATS TO VALIDITY

There are limitations and contextual variables in this study. Volunteer bias might have influenced participants' communications, potentially showing them on their "best behaviour". Another limitation is the reporting from one all-female team, which is an unequal representation compared to the all-male (n=3) and mixed-gender (n=4) teams. In addition, our study did not include a predominately female mixed-gender team, to identify the teamwork behaviours that emerge from this team composition. One more limitation is our inability to capture teams' communications outside of Slack, such as the teams' face-to-face meetings. These meetings might have generated gender-related behaviours that might have influenced the communications conducted over Slack. While we cannot claim that our findings generalise to other teamwork, the projects were designed to represent real-world software development settings as best as possible in a university setting by, asking students to contribute to large open-source projects.

7 DISCUSSION

In Section 5, the results show the female and male students responding with positive teamwork experiences. The results also show gender differences in the initiated teamwork behaviours, answering *RQ1: How is gender influence communication initiated within student teams?* Figures 3 and 4 demonstrate that female students were more communicative, but within certain conditions. Within the all-female team, team members showed a higher rate of seeking help from peers. A potential reason for their help seeking is *peer parity*. Peer parity occurs "when an individual can identify with at least one other peer when interacting in a community" [12, p. 1]. Peer parity might have also been present within Team-7 (Female=2, Male=3), encouraging higher engagement by the two female team members. Within the mixed-gender teams with a single female team member (Teams 2 and 6), the absence of peer parity might have contributed to their low team communication. These female students might have felt isolated within the team; feelings of isolation can be a demotivating factor that impedes learning [30].

We note the initial code *Feedback* was not applied by the teams. *Feedback* occurs when a team member gives, seeks, and receives information on their peers' contributions. The absence of this behaviour might be due to the feedback coming from the project owners. Students were reliant on the owners' feedback, since owners decided on accepting code changes to their projects. In this study, students relayed owners' feedback as *Coordination* behaviours. For example, *"we got the reply from the repo maintainer"* and *"our code has been merged!"*. Without external influences, like the project owners, other teamwork might initiate *Feedback* behaviour.

Though team roles were not defined in this study, teamwork behaviours did materialise, as was previously observed [34] within nonrole teams. Certain teamwork behaviours, *Team Leadership*, *Coordination*, and *Monitoring*, were primarily initiated by female students, as seen in Team-7 (Female=2, Male=3). These teamwork behaviours could be perceived as *pink tasks*; these are tasks that need "to be done on time and to a high standard, but where there is little substantive development or increased visibility for the person undertaking or assigned the tasks" [3, p. 3]. We surmise the initiated behaviours within Team-7 might be the result of *perceived feminine competencies*, a gender stereotype characterising women with better workplace relationship and communication competencies [37]; and as a result, Team-7 might have assumed that female members would take on these roles. More research is needed to better understand the behaviours observed in Team-7.

8 CONCLUSION

The purpose of this study is to identify gender differences that occur when student teams contribute to a large open-source software project. We used gender analysis to examine differences in initiated teamwork behaviours from female and male Software Engineering students. Our results show female students being more communicative during the project, mainly applying teamwork behaviours related to leadership, coordination, and monitoring peer's work to complete the project. Female students involved in an all-female team also sought out help from their peers, an infrequent behaviour in the all-male and mixed-gender teams.

Our findings raise future research opportunities to further investigate the gender differences observed in this study. More research is required to better understand the mixed-gender team dynamics, to determine whether the initiated teamwork behaviours from single female students in these teams are influenced by feelings of isolation or by gendered factors. Future work can further examine outcomes from initiated teamwork behaviours, to determine whether gender differences also exist in team members' reactions.

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