

# Google Summer of Code: Student Motivations and Contributions

Jefferson O. Silva, Igor Wiese, Daniel M. German, Christoph Treude, Marco A. Gerosa, Igor Steinmacher

---

## Abstract

Several open source software (OSS) projects participate in engagement programs like Summers of Code expecting to foster newcomers' onboarding and receive contributions. However, scant empirical evidence identifies why students join such programs. In this paper, we study the well-established Google Summer of Code (GSoC), which is a 3-month OSS engagement program that offers stipends and mentorship to students willing to contribute to OSS projects. We combined a survey (of students and mentors) and interviews (of students) to understand what motivates students to enter GSoC. Our results show that students enter GSoC for an enriching experience, and not necessarily to become frequent contributors. Our data suggest that, while stipends are an important motivator, students participate for work experience and the ability to enhance their resumés. We also discuss practical implications for students, mentors, OSS projects, and Summer of Code programs.

*Keywords:* Google Summer of Code, Motivation, Newcomers, Open Source Software

*2018 MSC:* 00-01, 99-00

---

## 1. Introduction

Summer of Code programs promote software development by students over the course of a few months [1, 2]. By participating in these programs, Open Source Software (OSS) projects expect to increase newcomers' retention and  
5 code contribution [2]. Examples of such programs include Google Summer of

Code,<sup>1</sup> Rails Girls Summer of Code,<sup>2</sup> Julia Summer of Code,<sup>3</sup> and Outreachy.<sup>4</sup> Some Summer of Code programs are sponsored by well-known organizations, such as Facebook, Debian, and Google [2, 3]. Students that participate in Summer of Code programs often have personal goals beyond becoming active  
10 OSS project contributors, such as building their CV or receiving stipends [4, 5].

Previous research has mostly focused on new ways to attract developers into OSS (e.g., [6, 7]), to retain them as long-term contributors (e.g., [8, 9, 10]), and to mitigate onboarding barriers (e.g., [11]). Regarding Summer of Code programs, the literature has focused on quantitative evaluations of the  
15 contributions made by the students during and after the programs [12] (for a few projects of the KDE community); and on the outcomes for the students that participated in these programs [2, 3, 13]. No research has focused on students' motivations to join an OSS project and the influence that participating in the program (such as the gain in reputation and the pecuniary benefits of joining  
20 the program) has on their motivations; neither has research explored mentors' (members of the OSS projects) perspectives on students' motivation.

Thus, the purpose of this study is to identify and understand what motivates students to participate in Google Summer of Code (GSoC) programs and to continue participating in the projects after the program ends. We chose to focus  
25 our study on GSoC because it is the oldest, largest, and best-known Summer of Code program. We collected data by means of surveys and interviews with students and mentors in order to promote triangulation of data sources. We designed the following research questions (RQ) to guide our research:

**RQ1.** According to students, what motivates them to participate in Summer  
30 of Code programs?

---

<sup>1</sup> <http://developers.google.com/open-source/gsoc/>

<sup>2</sup> <http://railsgirlssummerofcode.org/>

<sup>3</sup> <https://julialang.org/soc/archive.html>

<sup>4</sup> <http://www.outreachy.org/>

**RQ2.** According to mentors, what motivates students to participate in Summer of Code programs?

Our findings suggest that most students participate in Summer of Code programs to acquire experiences and technical skills that can be used later for career building. Nevertheless, for a small number of students, their desire to contribute to an OSS project—even after the programs—is more than a participation bonus, but an experience they do not want to forgo. We conjecture that OSS projects could increase the odds of achieving students’ retention by providing the students with participation rewards (e.g., certificates) aligned with the students’ interests (e.g., career building).

## 2. Background and Related Work

In this section, we summarize studies that tackled not only the newcomers’ self-guided involvement in OSS projects but also their involvement through Summers of Code. We start by explaining what Google Summer of Code is, how it works, and why we chose to study it.

### 2.1. *Google Summer of Code*

Google Summer of Code (GSoC) is a worldwide annual program sponsored by Google that offers students a stipend to write code for OSS for three months. We chose to study GSoC because it: is best-known compared to other programs; has been in operation since 2005; every year recruits lots of students from all over the world; and provides students with a comprehensive set of rewards, including participating in a well-known company’s program, community bonding, skill development, fun, career advancement, peer recognition, and a stipend [2].

Among its goals, GSoC aims to “Inspire young developers to begin participating in OSS development,” and “Help OSS projects identify and bring in new developers and committers.”<sup>5</sup> At the time of this writing, Google paid 3,000 to

---

<sup>5</sup> <https://google.github.io/gsocguides/student/>

6,600 USD (depending on the country) for students who successfully complete all phases of the program.

Applicants must write and submit project proposals to the OSS projects  
60 (previously approved by Google) they wish to work for. Accepted students spend a month learning about the organization’s community and then three months implementing their contribution, which is evaluated by the mentors before they receive the final payment.

## *2.2. Summer of Code Programs*

65 Summer of Code programs are becoming a common initiative to bring more contributors to OSS (e.g., Google Summer of Code, Julia Summer of Code), and to increase diversity (e.g., Outreachy, Rails Girls Summer of Code). Given Summer of Code aparent success, some researchers have targeted these programs to understand students’ retention. For example, Schilling et al. [12, 14]  
70 used the concepts of Person-Job (the congruence between an applicant’s desire and job supplies) and Person-Team (the applicant’s level of interpersonal compatibility with the existing team) from the recruitment literature. They found that intermediate (4-94 commits) and high (>94 commits) levels of previous development were strongly associated with retention. Trainer et al. [3] inter-  
75 viewed 15 students and identified the students gained new software engineering skills, and the students used their participation for career advancement. The authors [3] also found that mentors faced several challenges. In another study, Trainer et al. [2] analyzed 22 GSoC projects in the scientific software domain to understand GSoC outcomes. They found that GSoC facilitated the creation of  
80 strong ties between mentors and students, reporting that 18% of the students (n=22) became mentors in subsequent editions.

## *2.3. Motivation*

A conventional understanding among researchers seems to be that motivation refers to psychological needs that require satisfaction [15]. These needs can  
85 be acquired through the influence of the environment or they can be innate [16].

As with other practitioners, software engineers are influenced by their motivational state, which can determine the success or failure of software projects [17].

We focus on the OSS context, and it is out of the scope of this study to provide an exhaustive systematic review of motivational theories. Instead, we chose  
90 to study students' motivation using the constructs of intrinsic and extrinsic motivation and the Self-Determination Theory (SDT), which have been frequently used to analyze OSS project developers (see [18] and [19] for a review).

Intrinsically motivated behaviors do not require any 'rewards' other than those obtained from the satisfaction of performing them [15]. In contrast, ex-  
95 trinsically motivated behaviors comprise the pursuit of external rewards or the consequences derived from their performance [20]. Extrinsically motivated behaviors can undergo an internalization process, in which they are performed in various degrees of self-determination, including autonomously [20].

The SDT is a general motivational theory, which is concerned with motivation behind individual choices [15]. Several researchers built upon SDT to  
100 explain the heterogeneous nature of individual's motivation in a broad range of domains [18, 15], including OSS developers' motivation to contribute voluntarily to OSS projects. For example, several empirical studies found intrinsic motivation factors that played a significant role in motivating OSS developers, such  
105 as: *ideology* [5, 21] *altruism* [21, 22, 23]; *kinship* *amidity* [5, 24]; and *enjoyment* and *fun* [25, 5]

Several internalized extrinsic motivation factors were found to be important, such as *reputation* [21, 26, 27]; *reciprocity* [5, 27]; *learning* [21, 26, 28]; and *own use value* [5, 21, 29]. We highlight that the most commonly cited extrinsic  
110 motivation factors are *career building* [4, 29] and *stipends* [5, 29, 30].

#### 2.4. Newcomers' Onboarding

Typically, studies on retention take the perspective of the individual developer. Thereby, intrinsic motivation (e.g., [5, 29]), *social ties* with team members (e.g., [31, 32, 33]), *mentoring* (e.g., [34]), *project characteristics* (e.g., [7, 35, 6]),  
115 *ideology* (e.g., [36]), and *incentives* and *rewards* (e.g., [37, 38]) have been found

most relevant for OSS developers to continue contributing.

Zhou and Mockus [39] worked on identifying newcomers who are more likely to continue contributing. They found that the *individual's willingness* and the *project's climate* were associated with the odds that an individual would become a long-term contributor. Similarly, Wang and colleagues [40] proposed a prediction model to measure the chance for an OSS software developer to become a long-term contributor. The authors found that *willingness* and the *environment* were associated with newcomers becoming long-term contributors.

Fang and Neufeld [9] built upon the Legitimate Peripheral Participation (LPP) theory [41] to understand developers' motivation. Results from qualitative analyses revealed that *initial conditions to participate* did not adequately predict long-term participation, but that *situated learning* and *identity construction* behaviors were positively linked to sustained participation. From another perspective (including LPP lens), Sholler et al. [42] built upon existing literature to provide rules for helping newcomers become contributors to OSS projects.

### 3. Research Method

To answer our RQs, we conducted surveys with students and mentors and follow-up interviews with students. We conducted surveys not only to assess the motivational factors we found in the current literature but also to uncover potential new ones. Figure 1 outlines the research method we followed.

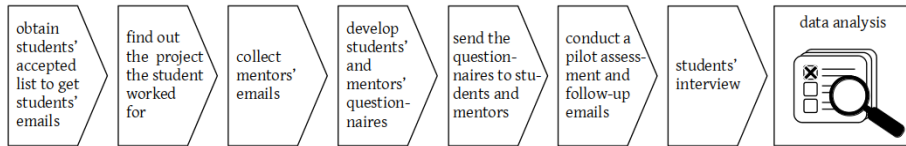


Figure 1: Research Method

#### 3.1. Contact information collection

We used the accepted students' list, published by Google, which contains the students' and the OSS organizations' names. Based on this information, we

investigated which specific project a student worked for, considering all the OSS  
140 projects under each organization. For example, although Google reports that  
the Apache Software Foundation (organization) accepted participant John Doe,  
we still do not know for which Apache project John worked. We considered  
that we found their emails when we had clear evidence linking the student with  
their corresponding project name. For instance, when we found a student web  
145 blog or professional resumé describing their experience in the program, or when  
we found their messages about the program in projects' discussion lists.

As the collection and verification of each student project is laborious and  
time-consuming, we limited our analysis to the GSoC 2010-2015 editions, in  
which approximately 7,000 students participated.<sup>6</sup> By the end of this step, we  
150 had gathered the emails of 1,000 students and 730 mentors.

### 3.1.1. *Questionnaire design and administration*

We used questionnaires as a data collection method, following Fink's advice  
on how to design surveys [43]. We asked students<sup>7</sup> about their contributions  
to OSS before and after GSoC (questions 1-5) and general questions about  
155 their participation in GSoC (questions 6-13). We also asked them questions  
that further explored the relationship between stipends and participation in  
GSoC (questions 14-15) and whether they would enter a hypothetical-GSoC  
that offered all motivational factors but one (question 16), which allowed us to  
rank and examine how essential these factors were. We concluded by asking  
160 them about demographic information at the time of their first participation  
(questions 17-22).

We designed the mentors' questionnaire<sup>8</sup> using the same structure as the  
students', with the difference that mentors had to answer about their students  
in general. It is worth emphasizing that we are aware that the mentors' an-  
165 swers may not refer to the students in our sample but they can provide a more

---

<sup>6</sup> <http://developers.google.com/open-source/gsoc/resources/stats>

<sup>7</sup> The students' questionnaire is available at <http://docs.google.com/forms/students>

<sup>8</sup> The mentors' questionnaire can be accessed at <http://docs.google.com/forms/mentors>

complementary point of view.

We conducted a pilot assessment of the questionnaire with 2 GSoC 2015 students. After minor adjustments, we sent out emails inviting students to participate in this research. We employed principles for increasing survey participation [44], such as sending personalized invitations, allowing participants to remain anonymous and sending follow up emails.

We sent out 1,000 survey invitations ( $\approx 14\%$  of the total GSoC students for the investigated period) to students and received answers from 141 students (14.1% response rate). We also sent out 730 survey invitations to mentors, and we received 53 responses (7.3% response rate). The number of survey invitations sent out to mentors is smaller than that of the students because a considerable number of mentors participate in more than one GSoC edition.

### 3.2. Analysis of survey responses

We employed descriptive statistics for analyzing the answers to the closed-ended questions and open coding and axial coding [45] for the open-ended ones. Open coding involves identifying codes and their properties in the data. Axial coding involves merging codes in order to reveal concepts and categories via a combination of inductive and deductive thinking [46].

The first author performed the open coding in the first stage, which resulted in 481 different codes. Two other authors collaborated to derive the 17 concepts from these codes. In the second stage, a third author reviewed the concepts and collaborated in the generation of the 7 categories presented in Table 2.

With our findings, we provide a selection of representative quotes from students and mentors, denoted respectively by  $S_{\#}$ , and  $M_{\#}$ , with their IDs in subscript. We also show in parentheses how many participants mentioned a category or concept. The counts represent how much evidence the data analysis yielded for each theme; they do not necessarily mean the importance of a theme.

### 3.3. Semi-Structured Interviews

We interviewed the surveyed students who volunteered for follow-up online interviews to illuminate some motivation factors that were still unclear. In addition,



tion, we wanted to get their perception of the coding scheme we derived during the survey analysis. We crafted the interview questions following Merriam’s [47] advice to stimulate interviewee responses.

We sent out 43 invitation emails and received 10 positive responses. The  
200 interviews lasted, on average, 23 minutes. At the end of the interviews, we presented and explained our coding scheme derived from the survey analysis, and asked for changes or insights that the students might have. Two interviewees suggested minor changes, such as including buying hardware equipment as one of the covered expenses.

### 205 3.4. Sample Characterization

Our sample comprises 112 male students, two females, and two self-identified as other. The predominant age for the first participation in GSoC was between 21-25 years old (63), followed by 18-20 years old (45). A minority of students were between 26-30 years old (26) and 31-40 years old (7). Regarding education,  
210 the respondents were mostly undergraduate students (58) or held a bachelor degree (41) students. A smaller number of students were graduate students (7) or held a graduate degree (6). Most participants had previous development experience ranging from 2-4 years (62), and 5-9 years (41).

In comparison, GSoC published statistics on students’ demographics for  
215 GSoC 2014<sup>9</sup> (we could not find other years’ detailed statistics). For that year, 10% of the students were females,  $\approx 68\%$  of them were undergraduates, and they were typically between 18-25 years old. Our sample matches these features.

We also analyzed the students’ distribution per country, shown in Table 1. We received answers from participants from 34 countries. Approximately 23%  
220 of the students resided in India and  $\approx 15\%$  of them in the USA. In comparison with GSoC published statistics from 2013,<sup>10</sup> 2014,<sup>11</sup> and 2015,<sup>12</sup> the sample is

---

<sup>9</sup> <https://opensource.googleblog.com/2014/06/gsoc-2014-by-numbers.html>

<sup>10</sup> <https://opensource.googleblog.com/2013/06/gsoc-2013-full-of.html>

<sup>11</sup> <https://opensource.googleblog.com/2014/05/gsoc-2014-by-numbers.html>

<sup>12</sup> <https://opensource.googleblog.com/2015/05/gsoc-2015-stats-about.html>

Table 1: Students' count per country of residence at the time of first participation

| <b>Country of residence</b>                                                                                                                              | <b>Count of countries</b> | <b>Count of students per country</b> | <b>% of students per country</b> |
|----------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|--------------------------------------|----------------------------------|
| India                                                                                                                                                    | 1                         | 33                                   | 23.4                             |
| USA                                                                                                                                                      | 1                         | 21                                   | 14.9                             |
| Brazil                                                                                                                                                   | 1                         | 8                                    | 5.7                              |
| Russia                                                                                                                                                   | 1                         | 7                                    | 5.0                              |
| Spain                                                                                                                                                    | 1                         | 6                                    | 4.3                              |
| Canada, France, Poland                                                                                                                                   | 3                         | 5                                    | 3.5                              |
| Romania, Sri Lanka                                                                                                                                       | 2                         | 4                                    | 2.8                              |
| Argentina, Germany, Ukraine                                                                                                                              | 3                         | 3                                    | 2.1                              |
| Austria, Hungary, Portugal, United Kingdom                                                                                                               | 4                         | 2                                    | 1.4                              |
| Australia, Belarus, Bosnia, China, Croatia, Czech Republic, Denmark, Egypt, Finland, Greece, Italy, Netherlands, New Zealand, Peru, South Africa, Sweden | 17                        | 1                                    | 0.7                              |
| Did not answer                                                                                                                                           | -                         | 10                                   | 7.1                              |
| Total                                                                                                                                                    | 34                        | 141                                  | 100.0                            |

also representative regarding country.

#### 3.4.1. Demographic information about mentors

All respondent mentors identified as males (53). Half of them were between 31-40 years old (27), 15 were more than 40, 10 were between 26-30, and only one was between 21-25. The respondents participated (as mentors) in: 1 edition (10); 2 editions (15); 3 editions (13); 5 editions (11); 6 editions (2); 7 editions (1); and 11 editions (1). Most mentors had more than ten years (44) of development experience, with a few that had seven years (5), six years (2), five years (1), and eight years (1).

## 4. Findings

In this section, we present our findings.

#### 4.1. Students’ Motivations to Join GSoC (RQ1)

Based on the literature (e.g., [17]), we asked how essential the following  
 235 motivation factors were for the students to participate in a hypothetical-GSoC  
 that offered all factors but one: career building (Q1); an entry gateway to OSS  
 projects (Q2); peer recognition (Q3); stipends (Q4); and intellectual stimula-  
 tion, such as a technical challenge (Q5). Figure 2 depicts when they agreed or  
 strongly agreed (5-level Likert items). We considered a motivation factor essen-  
 240 tial when the students reported they would give up entering the hypothetical-  
 GSoC without that factor.

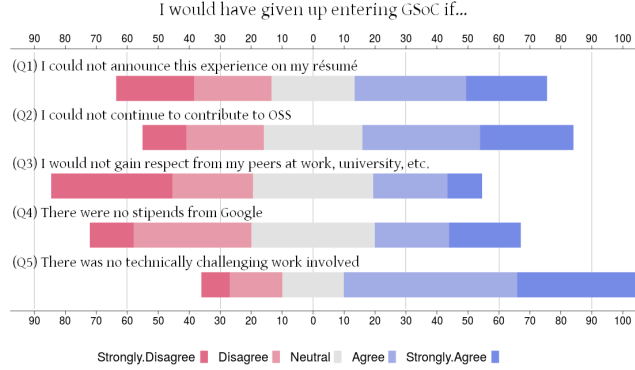


Figure 2: Students’ assessment of motivation factors for participating in GSoC

In Figure 3a, we offer an alternative perspective, with the students’ responses  
 presented in a graph, highlighting counts, proportions, and how the motivation  
 factors relate to each other in pairs. Each node in this figure indicates the num-  
 245 ber of students who considered that factor essential. Node sizes are proportional  
 to the counts. The edges depict the counts in the intersection of two motiva-  
 tion factors. Percentages show the proportion of the intersection in relation  
 to a node (i.e., motivation factor). In Figure 3b, we decompose the students’  
 response counts into sets and subsets, with the results shown in a Venn diagram.

250 The analysis of students’ textual answers yielded motivation factors other  
 than the ones that triggered our investigation, such as *learning* and *academic*  
 concerns. Table 2 presents all the concepts and categories derived from the

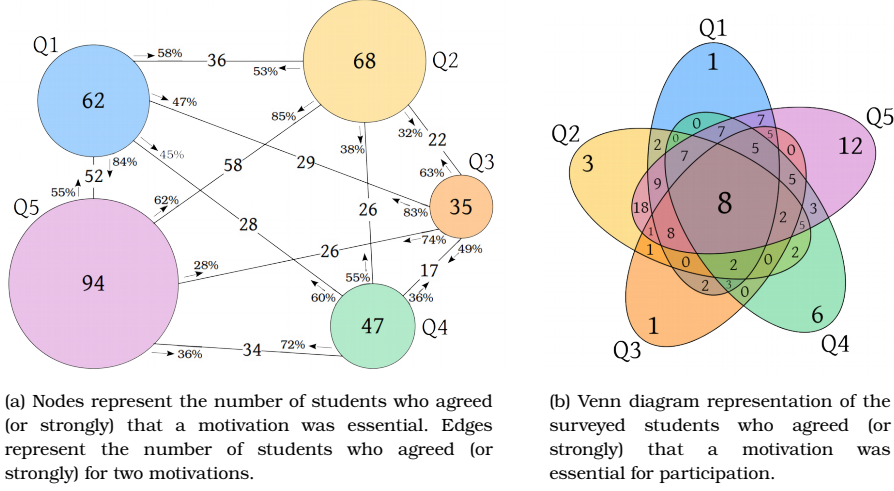


Figure 3: Surveyed students' motivation count in a graph (a) and in a Venn diagram (b).

Career building (Q1); contribute to OSS (Q2); peer recognition (Q3); stipends (Q4);  
technical challenge (Q5)

students' answers.

For readability concerns, we adopt the following convention to present the results in Table 2. Concepts are presented in True Type font (**concept**) (1). Categories are presented in italics (*category*) (1). Totals are presented in bold-face (**total**) (1). In all cases, the numbers in parentheses depict the counts. It is worth noting that all students that participated in the follow-up interviews validated the concepts and categories presented in Table 2. As  $S_9$  representatively said at the end of the interview: “Yeah, I mean, I can see myself interested in many of these points [the categories] right, I did it [GSoC] for most of them.”

#### 4.1.1. Career building

Approximately 44% of the students considered adding the GSoC experience to their CV essential (see Q1 in Figures 2 and 3), preferring not to participate otherwise. Aside from *technical challenge*, *career building* was the motivation factor students were the least divided about, with  $\approx 20\%$  of them being neutral on whether it was essential. Figure 3a depicts that the students motivated

Table 2: What motivates students to participate in Google Summer of Code?

| Categories (gray) and codes (white)          | # of students (%) | # of mentors (%) |
|----------------------------------------------|-------------------|------------------|
| Stipends (generic mentions)                  | 34 (24)           | 21 (40)          |
| Compensation for a provided service          | 10 (7)            | 0 (0)            |
| Source of funding                            | 13 (9)            | 2 (4)            |
| Payment of studies or tuition                | 13 (9)            | 0 (0)            |
| Project members                              | 12 (9)            | 0 (0)            |
| Currency conversion                          | 2 (1)             | 1 (2)            |
| <b>Total</b>                                 | <b>84 (60)</b>    | <b>24 (45)</b>   |
| Contribution to OSS (generic mentions)       | 27 (19)           | 2 (4)            |
| Interaction with mentor or other members     | 21 (15)           | 5 (9)            |
| OSS philosophy and culture                   | 16 (6)            | 0 (0)            |
| GSoC lowers entry barriers                   | 9 (6)             | 0 (0)            |
| OSS/GSoC project itself                      | 8 (15)            | 1 (2)            |
| <b>Total</b>                                 | <b>81 (57)</b>    | <b>8 (15)</b>    |
| Learning (generic mentions)                  | 5 (4)             | 4 (8)            |
| Real-world development experience            | 51 (36)           | 13 (25)          |
| Improvement of skills other than development | 2 (1)             | 0 (0)            |
| <b>Total</b>                                 | <b>58 (41)</b>    | <b>17 (32)</b>   |
| Career building (generic mentions)           | 7 (5)             | 0 (0)            |
| GSoC looks good on CV                        | 31 (22)           | 9 (17)           |
| <b>Total</b>                                 | <b>38 (27)</b>    | <b>9 (17)</b>    |
| Academic (generic mentions)                  | 7 (5)             | 1 (2)            |
| Course credit                                | 2 (1)             | 1 (2)            |
| Internships or summer projects               | 15 (11)           | 4 (8)            |
| Research purposes                            | 4 (3)             | 2 (4)            |
| <b>Total</b>                                 | <b>24 (17)</b>    | <b>6 (11)</b>    |
| Peer recognition (generic mentions)          | 0 (0)             | 1 (2)            |
| Prestige or bragging rights                  | 9 (6)             | 1 (2)            |
| <b>Total</b>                                 | <b>9 (6)</b>      | <b>2 (4)</b>     |
| Intellectual stimulation (generic mentions)  | 0 (0)             | 0 (0)            |
| Technically challenging work                 | 5 (4)             | 2 (4)            |
| <b>Total</b>                                 | <b>5 (4)</b>      | <b>2 (4)</b>     |

by *career building* were also mostly motivated by *technical challenge* (84%) followed by *contribution to OSS* (58%). Figure 3b reveals that only one student  
270 was purely motivated by *career building*.

We also analyzed students' textual answers to obtain additional information, which resulted in the concepts and categories shown in Table 2 (see *career building*). The analysis revealed, though not exclusively, that the students who mentioned the career as a motive for participation (27%) mostly entered the  
275 program because GSoC would look good on their CVs (31). Examples include S<sub>79</sub>: "(...) adding the 'Google' keyword on a resume was a good plus," and; S<sub>106</sub>: "I needed some real experience to my CV."

While a few other students considered *career building* (7) to be among their primary motivation, their mentions were only vague, as per S<sub>39</sub>: "I participated  
280 [in GSoC] because it was a great opportunity for my career." Moreover, **career**

**building** (38) was a concern for several interviewees who declared they would not have given it up (5), revealing that their careers would still benefit from the: **real-world development experience** (3); and **interacting with OSS project members** (2).

#### 285 4.1.2. Contribution to OSS

The students who explicitly stated they entered GSoC because they were motivated by contributing to OSS were grouped into the **contribution to OSS** (81) category (see Table 2).

Some students mentioned being driven by the **GSoC/OSS project itself** (8), such as S<sub>136</sub>: “*I wanted to add a feature to an open source media player, and I felt like GSoC would motivate me to implement this feature,*” and; S<sub>85</sub>: “*I was interested in contributing to Free/Open source libraries.*” The students did not mention they were interested in becoming frequent contributors.

We found cases of students who entered GSoC motivated by the **OSS culture and philosophy** (16), such as S<sub>73</sub> who said: “*I’m passionate about FOSS and all philosophy around it,*” and; S<sub>58</sub>: “*I was always attracted to the idea of contributing code for good.*”

Several OSS projects are known for having high entry barriers for newcomers [33], and in some cases, students considered that **GSoC lowers entry barriers** (9), such as S<sub>135</sub>: “*I wanted to get involved developing OSS but found there to be a high barrier to entry (...) The goal for me was primarily to help break into the OSS community, which felt difficult to penetrate at the time.*” More often, students considered GSoC an opportunity to **interact with OSS mentor or other community members** (21), such as S<sub>48</sub>, who said: 305 “*It was a chance to interact with an OSS community.*” Although most students were not contributors to the GSoC projects before kickoff (see Table 3), a significant minority (44%) had already contributed. Also, most of them reported having some previous experience contributing to OSS projects (see Table 4).

We also found students (2) that engaged in OSS projects to increase their 310 odds of participating in GSoC. As evidenced by S<sub>3</sub>: “*I knew I had to do GSoC for*

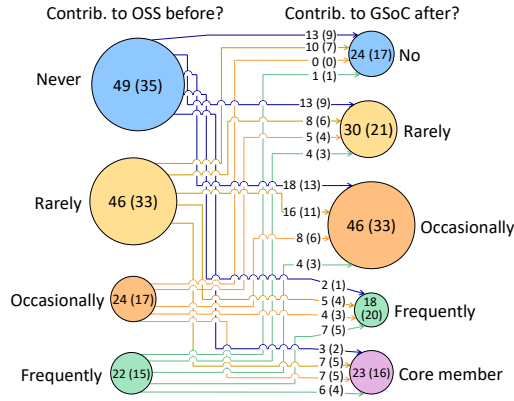


Figure 4: Contribution frequency to OSS Before and to the GSoC projects After the program. Students’ count (%).

which I started contributing to FOSS.” This confirms what we found in students’ and mentors’ blogs,<sup>13</sup> such as tips on how to be accepted, suggesting that the candidates get involved with the community to increase their chances. We also found this advice in community wikis: “*Previous contributions to Octave are a condition for acceptance. In this way, we hope to select students who are familiar with the codebase and able to start their project quickly.*”<sup>14</sup> Another strategy employed by students (2) was to select projects in which few other students would be interested.

Figure 4 illustrates the relationship between the self-reported contribution frequency to OSS projects before kickoff and the assigned GSoC projects after the program. We can observe that 75 students ( $\approx 53\%$ ) reported an increase in contribution frequencies after GSoC. The 29 students ( $\approx 21\%$ ) who before GSoC had occasionally (at most) contributed to OSS projects remained as such after the program concerning contributions to the GSoC projects. Also, the 13 students ( $\approx 9\%$ ) who self-reported to be frequent contributors to OSS projects before the program remained as such after the program concerning contributions

<sup>13</sup> <https://danielpocock.com/getting-selected-for-google-summer-of-code-2016>

<sup>14</sup> [https://wiki.octave.org/GSoC\\_2018\\_application](https://wiki.octave.org/GSoC_2018_application)

to GSoC projects. In contrast, 24 students ( $\approx 17\%$ ) lowered their contributions to GSoC projects compared to how frequently they contributed to OSS projects before the program’s kickoff.

330      Contributing to OSS projects was ranked as the second most essential motivator (see Figure 2a), which is also confirmed by the students’ coding (see Table 2). In addition, most students entered GSoC with intentions to continue contributing (‘Yes’ and ‘Definitely’, which totals  $\approx 57\%$ ) (see Table 5). Together, these results suggest high retention rates. However, we interpret (and moderate) 335 these results in light of our previous quantitative study [1], which revealed that only a fraction ( $\approx 16\%$ ) of the students kept contributing after a few months. In this sense, this research confirms the work of Roberts et al. [48], who found in a longitudinal study that initial developers’ motivations did not translate into increased retention. Nevertheless, both this research and our previous work [1] 340 suggest a small group of students indeed became frequent developers.

Table 3: Before GSoC, did you contribute to the project you’ve chosen for the program?

| Responses                  | Count (%) |
|----------------------------|-----------|
| Never                      | 79 (56.0) |
| Rarely                     | 19 (13.5) |
| Occasionally               | 10 (7.1)  |
| Frequently                 | 14 (9.9)  |
| My project started in GSoC | 13 (9.2)  |
| Core member                | 6 (4.3)   |

Table 4: Before GSoC, did you contribute to OSS projects other than your own?

| Responses    | Count (%) |
|--------------|-----------|
| Never        | 49 (34.7) |
| Rarely       | 46 (32.6) |
| Occasionally | 24 (17.0) |
| Frequently   | 22 (15.6) |

Table 5: Before GSoC, did you intend to continue contributing to the project?

| Responses      | Count (%) |
|----------------|-----------|
| Not at all     | 8 (5.7)   |
| No             | 11 (7.8)  |
| Maybe          | 42 (29.8) |
| Yes            | 40 (28.4) |
| Definitely yes | 40 (28.4) |

Table 6: Have you actually continued contributing?

| Responses    | Count (%) |
|--------------|-----------|
| No           | 24 (17.0) |
| Rarely       | 30 (21.3) |
| Occasionally | 46 (32.6) |
| Frequently   | 18 (12.8) |
| Core member  | 23 (16.3) |



#### 4.1.3. Peer recognition

Only a quarter of the students ( $\approx 25\%$ ) considered *peer recognition* essential for participation (see Q3 in Figure 2 and Figure 3). Often, students referred to  
345 *peer recognition* concerning **prestige** (5) of the program among their peers or **bragging rights** (4).

#### 4.1.4. Stipends

Around 30% of the students considered *stipends* essential for participating in GSoC, even though this motivation factor had the largest number of neutral  
350 students (see Figure 2 and Figure 3). Some students revealed the roles the *stipends* played. In several cases, students used the *stipends* for the **payment of their tuition** (13).

Often, the *stipends* were used as a **source of funding** (13). We used this concept when the *stipends* were used for **living expenses** (10), as a means to  
355 make students' participation feasible, such as explained by S<sub>115</sub>: "*I need to earn money for existence*", and S<sub>125</sub>: "*I needed the stipend for living expenses.*"

During the interviews, we found that students used the *stipends* to **buy hardware equipment** (1), coded as **source of funding** (13). As S<sub>47</sub> said: "*I used that [the stipends] to purchase hardware equipment so I could improve my  
360 development environment.*" Furthermore, we considered **source of funding** (13) when existing project members could **dedicate time and efforts to their projects** (2), such as S<sub>6</sub>: "*I was already contributing to the OSS project before the GSoC although that was in my free time. GSoC was a chance to really spend time for the project*"; and S<sub>111</sub>: "*GSoC was a chance for us to have a  
365 core member work on the project full time instead of just in the spare time and this helped to get lots of development and some crucial refactoring done.*"

Alternatively, other students viewed stipends as compensation for either the service provided or the time spent, which we labeled **stipends as compensation** (10), such as explained by S<sub>40</sub>: "*I would prefer to get paid for my time. Other-  
370 wise[, I would have] contributed to open source without GSoC.*"

Many responses mentioned the stipends to be significant, such as S<sub>84</sub>, who

commented: “*It was a really cool opportunity to [...] get a (huge) amount of money [...].*” Since the stipends’ role was not explicitly stated, we present these counts in the same line as the category. This rationale also was applied  
375 to students who were motivated by **currency conversion** (2) rates, such as S<sub>137</sub>, who said: “*For the financial incentive (which is quite a big amount in my country) and for the opportunity to contribute to OSS projects.*” These students resided in Sri Lanka and Belarus, respectively, when they participated in GSoC.

Stipend-motivated participation incited different sentiments in the students.  
380 Although most students’ responses were neutral (120) towards the stipends, some responses had a positive tone (8), typically linking the payments to the heart of the program. As S<sub>95</sub> answered when asked if he would enter a no-stipend hypothetical-GSoC: “*That’s a weird question, the point of GSoC is the stipend, [otherwise] there wouldn’t be any GSoC.*” On the other hand, we also  
385 identified a minority of students (3) with negative sentiments towards participation motivated by payments. As S<sub>52</sub> mentioned: “*There are many people who try GSoC merely for the money! That’s something of utter shame. People should contribute only if they’re genuinely interested and not for the money.*”

#### 4.1.5. Learning

390 Several students reported that the potential **learning** (58) experience provided by GSoC was among their motivations for participation, mostly for the **real-world development experience** (51), which means that the students wanted to improve their programming skills or be introduced to software engineering practices. As S<sub>67</sub> detailed: “*I was looking for an internship/summer  
395 experience and GSoC caught my eye because it seems like a good way to improve programming skills (...).*”

We also found evidence of some students motivated to enter GSoC because they wanted to **gain other skills** (2) (other than programming), such as S<sub>99</sub>, who described his interest: “*To improve English.*” In addition, a few students  
400 vaguely mentioned *learning* (5), without specifying what they wanted to learn.

#### 4.1.6. Academic

While a few students vaguely reported participating in GSoC for *academic* (7) concerns, others wanted an alternative to traditional **internships** (6). These students often indicated as a primary motivating factor the flexibility that GSoC offered, such as working remotely. S<sub>109</sub> exemplifies these cases: “It was a good summer internship, getting good internship locally was difficult for me.” The work conditions offered by GSoC motivated another student. As S<sub>118</sub> explained his interest: “[I] needed a [low-pressure] internship like this.”

Similarly, other students driven by *academic* motives mentioned the need for the accomplishment of **summer projects** (9). As S<sub>58</sub> said: “I was looking for a summer project.” Due to the similarity, we grouped the concepts **internships** (6) and **summer projects** (9) into a single **internships/summer projects** (15) concept. Also, graduate students mentioned participating in the program for **research purposes** (4), such as S<sub>130</sub>, who commented: “I was a graduate student looking for summer funding and I wanted to improve my coding for my research.”

During the interview, two students added that participation in GSoC could be used for obtaining **course credits** (2) in their college. As S<sub>5</sub> said: “There are some students I know that specifically did GSoC for the college course credit.”

#### 4.1.7. Technical challenge

Approximately 67% of the students considered *technical challenge* essential for participation (see Q5 in Figure 2 and Figure 3). It was the motivation factor for which the largest number of students declared they would not enter GSoC without and that the students were least divided.

Surprisingly, analyzing our coding we found that **technical challenge** (5) was the least mentioned motivation factor (see Table 2), with only a few mentions. Still, these mentions were subtle. For instance, S<sub>72</sub> said: “It’s challenging, it’s interesting, and it’s [paid].”

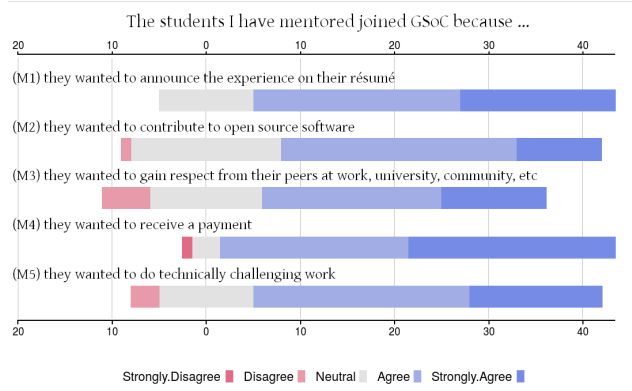


Figure 5: Mentors' perception on the students' motivation for entering GSoC

**Answer for RQ1:** Based on our data, the students typically entered GSoC for a paid experience in which they could use the practical knowledge obtained from participation for building their career portfolio. Nevertheless, some students entered mainly to be able to contribute to OSS projects.

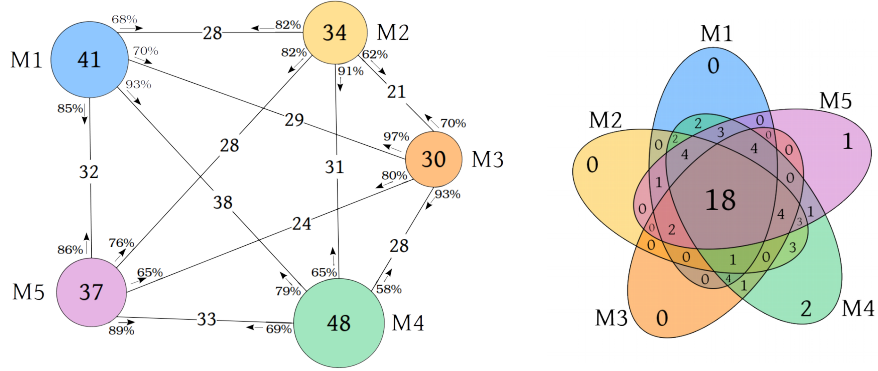
Although it is not the focus of this research to investigate differences in students' motivation by gender, country of residence, and education level, we offer some analysis under these perspectives. Our sample indicates that GSoC is male-oriented (as is the broader software engineering field) and our data is insufficient for segmenting by gender. We did not find significant differences in students' motivation when we grouped the countries of residence by development level. Finally, career-driven participations seems correlated with an age group (21-25). Additional research is necessary to understand these differences.

#### 4.2. Students' Motivations From Mentors' Perspective (RQ2)

Figure 5 depicts the mentors' assessment on how essential the investigated motivation factors were for students to join GSoC. Similarly to Figure 3, Figure 6 offers additional perspectives.

##### 4.2.1. Career building

Approximately 77% of mentors agreed that students entered GSoC so they could include the experience in their CV (see M1 in Figure 5 and Figure 6). It



(a) Nodes represent the number of mentors who agreed (or strongly) that a motivation was essential. Edges represent the number of mentors who agreed (or strongly) for two motivations

(b) Venn diagram representation of the surveyed mentors who agreed (or strongly) that a motivation was essential for participation

Figure 6: Count of students' motivation according to mentors in a graph (a) and in a Venn diagram (b). Career building (M1); contribution to OSS (M2); peer recognition (M3); stipends (M4); technical challenge (M5)

445 is worth noting that *career building* was the only motivating factor for which no mentor disagreed that it was essential for students.

In Figure 6a, we can observe that virtually all the mentors who agreed that *career building* was essential (M1, edge: 93%) also agreed that *stipends* were essential (M4). The remaining edges equally show that more than 2/3 of  
 450 the mentors in M1 also considered the remaining motivation factors essential. Figure 6b shows that no mentor perceived students as only trying to improve their CVs by participating in GSoC. Instead, mentors tended to assess students' motivations as multifaceted to the point that approximately 1/3 of the mentors (18 mentors) considered all motivation factors essential for participation.

455 In the answers to our open-ended questions, some mentors mentioned **CV improvement** (9) as a motive for students to enter GSoC. As M<sub>36</sub> representatively said: “*They [the students] are interested in building their CV, being recognized as part of a Google's program.*”

#### 4.2.2. Contribution to OSS

460      Around 64% of mentors agreed that students joined GSoC motivated by the  
*contribution to OSS* (see M2 in Figure 5 and Figure 6). While *contribution to*  
*OSS* was the second most essential motivation factor in the students' perception,  
mentors' assessment was that *contribution to OSS* is the second least essential  
factor (compare Q2 in Figure 2 to M2 in Figure 5).

465      In general, mentors perceived students as contributors to OSS projects (see  
Table 7a and b), though in several cases mentors classified contribution fre-  
quency as rare. This perception may explain why mentors possibly underesti-  
mated (compared to the other factors) how essential *contribution to OSS* was for  
the students, since in mentors' views most students already had that experience.

470      We also found potential disparities among mentors' and students' percep-  
tion regarding contributing to OSS before GSoC. In Table 7a, we can observe  
that  $\approx 13\%$  of the mentors in our sample assumed that students had never  
contributed to OSS, while  $\approx 35\%$  of the students self-reported to have never  
contributed to OSS before GSoC. On the other hand, while  $\approx 3\%$  of the mentors  
475      reported that students were frequent contributors before GSoC (see Table 7a),  
16% of the students self-reported to be frequent contributors (compare to Ta-  
ble 4). A similar disparity occurs when we compare the students' (Table 3 and  
mentors' (Table 7b) perceptions of the frequency of previous contributions to  
GSoC projects.

480      These disparities can be in part explained by the fact that the students were  
not necessarily first-timers, but they were active project contributors before  
GSoC, and started contributing to OSS/GSoC projects to increase the odds  
of being accepted in GSoC. Another possible explanation is that students' and  
mentors' views differed towards what they considered a frequent contributor.

485      Figure 6 shows that mentors perceived a strong link between the *contribu-*  
*tion to OSS* and *stipends* factors. We observed that 91% of the mentors who  
considered *contribution to OSS* an essential motivation factor did the same for  
*stipends* (see M2 in Figure 6a). The remaining factors also had more than 2/3

Table 7: (a) In your experience, how often were your GSoC students contributors to OSS software projects (other than their own) before the program?

(b) Were they already contributors to the project you mentored before GSoC?

(c) How often do students keep contributing to the projects you mentored after the program?

| Responses    | Count (%) | Count (%) | Count (%) |
|--------------|-----------|-----------|-----------|
| I don't know | 4 (6.4)   | 0 (0.0)   | 1 (1.9)   |
| Never        | 8 (12.7)  | 23 (43.4) | 8 (15.1)  |
| Rarely       | 20 (31.7) | 14 (26.4) | 16 (30.2) |
| Occasionally | 19 (30.2) | 14 (26.4) | 18 (34.0) |
| Frequently   | 2 (3.2)   | 2 (3.8)   | 10 (18.9) |
|              | (a)       | (b)       | (c)       |

of the mentors who considered them essential, except for *peer recognition* (M3).

490 The coding of mentors' answers revealed that **interaction with the OSS community members** (5) is a primary interest, even though there was a subtle mention to the **OSS project itself** (1) as a motive. We also found evidence that the GSoC selection process can potentially make candidates contribute to OSS projects as a means to gain acceptance in the program (1).

#### 495 4.2.3. *Peer recognition*

Around 57% of mentors considered *peer recognition* an essential motivation for students, being the least essential when compared to the other factors (see M3 in Figure 5 and Figure 6). This finding is consistent with the students' assessment, who also ranked *peer recognition* the least essential motivation factor.

500 In Figure 6a, we can observe that virtually every mentor who considered *peer recognition* essential also did the same for *career building* (see M3, edge: 97%) and *stipends* (see M3, edge: 93%), although more than 2/3 of mentors considered the other motivation factors essential. In their textual answers, mentors rarely mentioned **peer recognition** (2) as a motive for participating in GSoC, and we only found two subtle mentions. M<sub>15</sub>: "*Kudos and getting paid*" and M<sub>27</sub>, who was more specific: "*...for bragging rights.*"

#### 4.2.4. Stipends

According to mentors, the *stipends* were an essential motivation factor for students (see M4 in Figure 5 and Figure 6), with a consensus of  $\approx 91\%$ . We  
510 can see in Figure 6a that most mentors classified students' motivation as a combination of *stipends* and other factors, typically *career building* ( $\approx 79\%$  of cases). In Figure 6b, we can observe that two mentors judged that *stipends* alone sufficed for students to enter GSoC.

The coding of mentors' answers was consistent with the previous finding,  
515 showing that the **stipends** (24) were the most cited motivation factor for participation (see Table 2), even though often the mentors mentioned the *stipends* (21) broadly, without offering any context.

Nevertheless, a few mentors mentioned stipends as a **source of funding** (2). For instance, when M<sub>40</sub> commented on what his students were most inter-  
520 ested in when entering GSoC: "*Money. Honestly, they're students, which I'm pretty sure is a synonym for starving and broke.*" We also could find evidence for **currency conversion** (1) as a motive for participation. For example, M<sub>10</sub> said: "*The money seems to be a strong incentive. Especially in countries where approx \$5,500 USD carries a lot of purchasing power.*" No mentor mentioned  
525 **stipends as compensation** (0) as a motive.

Additionally, while several mentors who commented on *stipends* as a motive implied a neutral (30) or positive (1) tone in their answers, some mentors (3) indicated a negative tone. As M<sub>2</sub> said: "*Sadly, the money*"; and M<sub>46</sub>: "*I guess good students are more interested in learning and contributing, and not so good*  
530 *students by improving their CV and money*"; and M<sub>33</sub>, who commented: "*Many of the students I have mentored (15 or so at this point?) seemed to want to do the bare minimum to pass their deadlines and get paid.*" Encouragingly, we found evidence of mentors with a different experience. As M<sub>11</sub> said: "*Money is a strong motivator to join the program obviously, but most of them continue*  
535 *contributing after that factor disappears.*"



#### 4.2.5. Technical challenge

Around 70% of mentors agreed that the **technical challenge** (2) that the GSoC projects placed on their students is something the students desired (see M4 in Figure 5). However, as with the students' answers, the **technical challenge** (2) motivation factor had few mentions in mentors' coding.

#### 4.2.6. Academic

Many mentors mentioned that **academic** (6) concerns motivated students to enter GSoC. Except for a single generic mention to *academic* (1) as a motivation factor, mentors identified that their students entered GSoC for **course credits** (1), for **research purposes** (4), and **internship/summer projects** (4).

#### 4.2.7. Learning

Several mentors commented that **learning** (17) plays a central role in motivating students to enter GSoC. Only a few mentors mentioned *learning* (4) broadly. More commonly, mentors linked *learning* to the acquiring of **real-world development experience** (13).

**Answer for RQ2:** Mentors in our sample perceive their students as entering GSoC for the technical learning, in a favorable environment, which the mentors portrayed as including stipends and mentoring, mainly for building the students' career portfolio.

## 5. Discussion

Here, we review and discuss our findings. The literature on motivations to join OSS is mostly focused on contributors who are self-guided volunteers. In this research, we investigate whether the introduction of incentives offered by Summer of Code programs add new elements to the students' motivation.

(RQ1) Our research is the first to document what motivates students to participate in Summer of Code programs (Table 2). Even if some of the factors are similar to the context in which OSS developers voluntarily contribute to OSS projects (see [19] for a review) the contribution to the projects through

Summer of Code is quite different, leading to a different prioritization of factors. Additionally, three motivating factors seem to be new: participating in GSoC to *take advantage of currency conversion*; *obtaining course credits*, and; *lowering OSS projects' entry barriers*.

565 (RQ2) We also document the mentors' perception of the students' motivations (see Table 2), which is also not targeted by previous research. Mentors provide a perspective that considers the project's point of view, the comparison to non-GSoC newcomers, and an external view of the students' motivation to enter Summer of Code programs. In essence, mentors perceived students' mo-  
570 tivation as a pursuit of tangible rewards such as *stipends*, and the *learning of technical skills* that benefit *career building*.

Regarding students' retention, our findings suggest that most students do not continue contributing to GSoC projects after the program, regardless of their initial intentions (see Table 5). This finding is supported by our previ-  
575 ous work [1], in which we found that most students stopped contributing after GSoC, while the students who remained had only a few commits to the GSoC projects. Encouragingly, as with the findings of this research (see Figure 2 and Figure 3), our previous work [1] indicated that some students became frequent contributors after GSoC. Thus, it seems that most students enter the program  
580 for an enriching (work) experience that cannot be detached from the name of a high profile software company (such as Google). In this sense, our findings suggest that most OSS projects can expect feature development from participating in GSoC. Furthermore, our findings suggest that students are reluctant to admit financial motivation according to mentors' answers.

585 Nevertheless, we could notice that students with 2 to 5 years (61 students) of previous software development experience would still enter a hypothetical-GSoC that did not offer any stipends, as opposed to the ones with the same time experience who would not (20). In contrast, the students with 10 or more years (15 students) of prior development experience would not enter a hypothetical-GSoC  
590 with no payments, as opposed to the ones within the same experience range (5) who would still enter. Therefore, although the stipend is an important moti-

vator, it seems to be essential for participation for students with high software development experience, while the students who lack development experience value participation in GSoC for boosting their careers.

595 Indeed, low retention levels (or high levels of absenteeism in some contexts) are the most expected outcome in volunteer engagement programs (see [49] for the firefighting community in the USA; [50] for blood donation; and [51, 52] for online communities). Encouragingly, regardless of their motivation for entering GSoC, students self-reported an increase of their previous contribution level to  
600 the assigned GSoC projects in  $\approx 53\%$  of cases (see Figure 4).

Nevertheless, low retention rates may be demotivating for some mentors, mainly because they invest a lot of effort and time into mentoring. As mentioned by a mentor: “*I participated in GSoC as a mentor (...) While it didn’t ‘cost’ me anything in dollars, it cost me probably 200 hours of my time.*”<sup>15</sup> High-  
605 quality mentoring is labor-intensive and time-consuming and, in several cases, offered by volunteer OSS project members. While offering dedicated mentorship in addition to designing a high-level Summer of Code project could potentially enrich students’ experience in contributing to OSS projects, it may have the adverse effect of lowering mentors motivation. This seems to be a dilemma faced  
610 by the Debian community, which decided not to participate in GSoC 2017, as shown by the following excerpt from a notification email: “*Debian will not take part [in GSoC] this year. Some of our recurring mentors have shown some signs of ‘GSoC fatigue,’ (...) let’s have a summer to ourselves to recover (...) and come back next year.*” As previous research has shown that mentors themselves  
615 also face barriers [53], our findings may—to some degree—assist mentors by showing in what aspects of GSoC the students are most interested.

Our findings revealed that there are students whose primary goal was to participate in GSoC, and not necessarily to contribute to OSS projects. We speculate that these students otherwise would not have contributed to OSS  
620 projects. In addition, we conjecture that Summer of Code programs can poten-

---

<sup>15</sup> [https://mail-archives.apache.org/mod\\_mbox/community-dev/rcbowen.com](https://mail-archives.apache.org/mod_mbox/community-dev/rcbowen.com)

tially assist students in overcoming several of the onboarding barriers reported by Steinmacher et al. [11], which can be investigated in future research.

Previous research reports positive associations between receiving stipends and participating in OSS projects [48]. However, we found that the goals among stipend-driven students can differ. While some students see the stipend as compensation for a service, others need it for living expenses or buying hardware equipment. Our findings trigger some questions for future research to understand these associations at a finer-grained level.

### 5.1. Implications

We list some implications of this study for different stakeholders.

*OSS Projects.* OSS project members should moderate their expectations about gaining long-term contributors. Although GSoC increased participation in GSoC projects in general, our findings suggest that most OSS projects did not achieve long-term contributors. Our data indicate that the OSS projects should consider GSoC as an investment in students' experience in exchange for software feature development. OSS projects should consider that most of the students in our sample intended to become frequent contributors and a significant minority were neutral (see Table 5). This intention signals that providing students with rewards (e.g., certificates of contribution) that are meaningful to their goals (e.g., career building) should increase retention (or at least participation) rates. An alternative is to reward the students with seals of contribution or certificates associated with software companies (which do not need to sponsor students), enabling them to add these to their resumé. In addition, Trainer and colleagues [2] reported that the development of strong ties between students and project members (especially mentors) is associated with long-term contributions. We conjecture that this scheme could also be used with applicants not accepted in GSoC. Furthermore, GSoC is very competitive from the students' perspective. Thus, OSS projects should leverage contributions by attracting newcomers before GSoC, which not only could result in more contributions but also give mentors more time to assess suitable candidates.

*Students.* Students who want to take part as Summers of Code participants can benefit from the results of this study in many ways. First, our results show that students are encouraged by OSS projects to get involved before the selection process, so they can showcase their abilities and willingness, which in turn  
655 increases their odds of being accepted. Second, we observed that Summers of Code bring rewards to the participants beyond stipends. Students see these programs as great opportunities to build a portfolio and jumpstart their career, as can be observed in Table 2. Participants from developing countries report that participating in a program like GSoC increases students' visibility when  
660 seeking a job in a large corporation. In addition, some students consider participating in GSoC as a chance for networking, enabling them to interact with OSS contributors and with the "top of field people," as shown in Table 2. Third, students consider Summer of Code programs a good and flexible internship. They enable students to participate in internships who, for example, cannot commute  
665 or need to help their families during summer break.

*Summers of Code organizers.* It is crucial that the organizers observe and value career advancements, by, for example, easing access to the participants' list and providing certificates, similar to what GSoC does. While looking online for the participants' email addresses, we analyzed the students' professional social net-  
670 works profiles and noted that they indeed list the participation in GSoC as job experience. We observed that a great part of the students' motives is unrelated to the stipends (see Table 2). Therefore, existing and potential new programs could offer the students a chance to participate without offering stipends. The projects would benefit from more newcomers, and the students would benefit  
675 from the non-monetary rewards that the program offers. Since students are motivated by networking, Summers of Code programs could consider organizing regional meetups, inviting project members and participants, so they have a chance to meet the regional project members in person. Lastly, since par-

participants come from all over the world (see statistics for 2017,)<sup>16</sup> Summer of  
680 Code organizers should consider organizing the program in different periods, or  
making the calendar more flexible, as this would benefit students from countries  
where the three-month break occurs from December to February.

*Universities.* Universities can also benefit from our results. Although Google  
does not classify GSoC as an internship,<sup>17</sup> *we evidenced that some universi-*  
685 *ties use students' participation in the program to validate course credits.* Thus,  
universities could use our results to provide incentives and support students to  
participate in GSoC as a way to both help the students and contribute to OSS.  
The students would gain coding experience in a real setting, and would be ex-  
posed to real challenges. The experience of a GSoC student could potentially  
690 enrich the experience of other students. Additionally, validating course credits  
would be especially interesting for universities distant from major cities, where  
internship possibilities do not offer the technical challenges necessary to enable  
students to put what they learned into practice.

*Research.* This work offers opportunities for researchers to extend our findings.  
695 *Legitimate Peripheral Participation (LPP).* LPP is frequently used to explain  
how newcomers engage in OSS projects (communities of practice) [9]. However,  
our data indicate that LPP does not precisely describe the engagement process  
in OSS in GSoC in at least two ways. First, LPP assumes that students and  
mentors share the same goals, which would be to become frequent contributors  
700 to OSS projects. However, our findings indicate that most of the students in  
our sample were not primarily motivated to become frequent contributors (see  
Table 2). Second, contributing to OSS through GSoC may change the engage-  
ment process described by LPP. In several instances, students did not start at  
the margin, by first observing experienced members. Instead, they were individ-  
705 ually guided—and sponsored—to become contributors. According to LPP, by

---

<sup>16</sup> <https://developers.google.com/open-source/gsoc/resources/stats#2017>

<sup>17</sup> <https://developers.google.com/open-source/gsoc/faq>

successfully contributing peripheral tasks, apprentices should be gradually legitimized by experienced members. Instead, the student-OSS-project relationship in a Summer-of-Code context is mediated by a contract. Thus, Summer-of-Code students have the time to dedicate themselves to the GSoC project, which  
710 provides them with an opportunity to develop strong social ties to mentors. Nevertheless, it is not clear from our data if relationships mediated by contracts could, in fact, legitimize students. Therefore, our findings indicate that more research is necessary to understand how students can be legitimized as project members in a Summer of Code context.

715 *Self-Determination Theory (SDT).* Deci and Ryan [15] suggested that an understanding of the effects of (participation) rewards requires a consideration of how the recipients (students) are likely to interpret the rewards. In particular, this interpretation is directly linked to the feelings of self-determination (autonomy) and competence (self-efficacy), which may affect intrinsic motivation.  
720 Even though we found that students' motivation comprises multiple dimensions, no research has focused on the effects of the rewards on intrinsic motivation, which several researchers consider essential in the OSS context (e.g., [5, 48, 27]).

*Mentors.* We observed only students' motivation. However, to the best of our knowledge, mentors' motivation remains understudied. Understanding what  
725 drives mentors to support newcomers could benefit OSS projects and newcomers. Furthermore, it would be interesting to create an array of strategies that mentors use to deal with common problems such as candidates' selection, project creation, mentoring guidelines, and others.

*Demographics.* Researchers could study students' demographics and how  
730 (or whether) potential differences influence students' motivation and contribution. Additional research is necessary to understand how companies consider participation in Summers of Code in their hiring processes.

## 6. Limitations

This research has limitations, as described in the following.

735 *Internal validity.* Surveys are typically subject to *sampling* bias, namely *self-*  
selection bias, which could distort our sample towards the students and mentors  
who chose to participate. Also, our sample of students and mentors is not suffi-  
ciently large for statistically grounded inferences. These threats could result in  
a biased sample, in which case it would not be representative of the actual popu-  
740 lation of students and mentors. Nevertheless, our focus is not on understanding  
how generalizable the motivation factors we found are but on identifying them.

Also, *social desirability* can affect our data. For example, our data include  
negative viewpoints of students towards stipend-driven participation, which  
could indicate that a more significant number of students can perceive this factor  
745 as undesirable, underreporting (consciously or not) how essential the stipends  
were for their engagement.

Another threat is the data classifications’ subjectivity. We used coding pro-  
cedures to mitigate this threat, given that our findings are grounded in the data  
collected. Additionally, we discussed the analysis process, codes, concepts, cate-  
750 gories, and the findings among the authors to promote a better validation of the  
interpretations through agreement. Moreover, the data collected via Likert-scale  
in the survey and follow-up interviews confirmed our coding scheme.

*External validity.* The main limitation affecting external validity is our focus  
on GSoC. Also, we only investigated the GSoC editions from 2010-2015. Also,  
755 as few respondents identified themselves as female or other, our results may be  
biased towards males. Although we are confident that most of our results are  
also valid in other settings, we leave this investigation to future research.

## 7. Conclusion

In this paper, we investigated what motivates students to participate in  
760 Google Summer of Code (GSoC). More specifically, we surveyed 141 students  
and 53 mentors that participated in different GSoC editions, followed by ten  
confirmatory interviews.



Our findings suggest that students typically participate in GSoC to gain work experience, rather than with the intention to become a frequent OSS contributor. We also revealed that the students considered essential for participation: *technical challenge*, *contributing to OSS*, *build their careers*, *stipends*, *peer recognition*, *learning*, and *academic concerns*. From the mentors' perspective, students' motivation is mostly related to tangible rewards, such as stipends and technical learning that can benefit career building. In general, we found that participation in Summers of Code provided some OSS projects with new collaborators, even though this is not the typical scenario. OSS projects can use our findings to design strategies to increase attractiveness and retention.

We plan to extend the analysis of our data in different ways. In this work, we performed the *open coding* and *axial coding* to analyze the students' and mentors' answers. Our future work includes performing *theory building*, which is the last step of the grounded theory procedures [54], and validating the theory with students who did not participate in Summer of Code programs. Also, we plan to deepen the quantitative analysis of our data, which includes collecting additional data and exploring whether our findings differ concerning the country, age, and previous development experience.

## 8. Acknowledgement

This work is partially supported by the CNPq (430642/2016-4); FAPESP (Grant 2015/24527-3); and the National Science Foundation (Grant numbers 1815503 and 1900903)

## References

- [1] J. O. Silva, I. Wiese, D. German, I. Steinmacher, M. A. Gerosa, How Long and How Much : What to Expect from Summer of Code Participants?, in: 33rd International Conference on Software Maintenance and Evolution (ICSME), 2017, p. 10.

- 790 [2] E. H. Trainer, C. Chaihirunkarn, A. Kalyanasundaram, J. D. Herbsleb, Community Code Engagements: Summer of Code & Hackathons for Community Building in Scientific Software, in: 18th International Conference on Supporting Group Work (GROUP), no. 10, 2014, pp. 111–121.
- [3] E. H. Trainer, C. Chaihirunkarn, J. D. Herbsleb, The Big Effects of Short-term Efforts: Mentorship and Code Integration in Open Source Scientific Software, *Journal of Open Research Software* 2 (1) (2014) e18.
- 795 [4] J. Tirole, J. Lerner, Some Simple Economics of Open Source, *The Journal of Industrial Economics* 50 (2) (2002) 197–234.
- [5] K. R. Lakhani, R. G. Wolf, Why Hackers Do What They Do: Understanding Motivation and Effort in Free/Open Source Software Projects, in: Perspectives on Free and Open Source Software, MIT Press, 2005, p. 570.
- 800 [6] P. Meirelles, C. Santos Jr, J. Miranda, F. Kon, A. Terceiro, C. Chavez, A Study of the Relationships between Source Code Metrics and Attractiveness in Free Software Projects, in: 24th Brazilian Symposium on Software Engineering, SBES 2010, IEEE, Salvador, Brazil, 2010, pp. 11–20.
- 805 [7] C. Santos, G. Kuk, F. Kon, J. Pearson, The attraction of contributors in free and open source software projects, *The Journal of Strategic Information Systems* 22 (1) (2013) 26–45.
- [8] G. Von Krogh, S. Spaeth, K. R. Lakhani, Community, joining, and specialization in open source software innovation: A case study, *Research Policy* 32 (7) (2003) 1217–1241.
- 810 [9] Y. Fang, D. Neufeld, Understanding Sustained Participation in Open Source Software Projects, *Journal of Management Information Systems* 25 (4) (2009) 9–50.
- [10] N. Ducheneaut, Socialization in an Open Source Software Community: A Socio-Technical Analysis, *Computer Supported Cooperative Work* 14 (4) (2005) 323–368.

- [11] I. Steinmacher, M. A. Gerosa, D. F. Redmiles, T. Conte, M. A. Gerosa, D. F. Redmiles, Social Barriers Faced by Newcomers Placing Their First Contribution in Open Source Software Projects, 18th ACM Conference on Computer Supported Cooperative Work & Social Computing - CSCW '15 (2015) 1379–1392.
- [12] A. Schilling, S. Laumer, T. Weitzel, Who Will Remain? An Evaluation of Actual Person-Job and Person-Team Fit to Predict Developer Retention in FLOSS Projects, in: Annual Hawaii International Conference on System Sciences (HICSS), 2012, pp. 3446–3455.
- [13] E. H. Trainer, A. Kalyanasundaram, C. Chaihirunkarn, J. D. Herbsleb, How to Hackathon: Socio-technical Tradeoffs in Brief, Intensive Collocation, in: 19th ACM Conference on Computer-Supported Cooperative Work & Social Computing - CSCW '16, 2016, pp. 1116–1128.
- [14] A. Schilling, S. Laumer, T. Weitzel, Is the Source Strong With You? a Fit Perspective To Predict Sustained Participation of Floss Developers, in: 32nd International Conference on Information Systems, 2011.
- [15] E. L. Deci, R. M. Ryan, A meta-analytic review of experiments examining the effects of extrinsic rewards on intrinsic motivation., Psychological Bulletin 125 (6) (1999) 627–668.
- [16] M. M. Mason, Motivation, satisfaction, and innate psychological needs, International Journal of Doctoral Studies 7 (2012) 259–277.
- [17] S. Beecham, N. Baddoo, T. Hall, H. Robinson, H. Sharp, Motivation in Software Engineering: A systematic literature review, Information and Software Technology 50 (9-10) (2008) 860–878.
- [18] H. Benbya, N. Belbaly, Understanding Developers' Motives in Open Source Projects: A Multi-Theoretical Framework, Communications of the Association for Information Systems 27 (October) (2010) 589–610.

- 845 [19] G. von Krogh, S. Haefliger, S. Spaeth, M. W. Wallin, Carrots and rainbows: Motivation and social practice in open source software development, *MIS Quarterly* 36 (2) (2012) 649–676.
- [20] C. Scott Rigby, E. L. Deci, B. C. Patrick, R. M. Ryan, Beyond the intrinsic-extrinsic dichotomy: Self-determination in motivation and learning, *Motivation and Emotion* 16 (3) (1992) 165–185.
- 850 [21] R. A. Ghosh, Understanding free software developers: findings from the FLOSS study, *Perspectives on Free and Open Source Software* (2005) 23–45.
- [22] J. Bitzer, W. Schrettl, P. Schröder, Intrinsic Motivation in Open Source Software Development, *Journal of Comparative Economic* 35 (1) (2007) 160–169.
- 855 [23] E. Haruvy, A. Prasad, S. Sethi, Harvesting Altruism in Open-Source Software Development, *Journal of Optimization Theory and Applications* 118 (2) (2003) 381–416.
- [24] P. A. David, J. S. Shapiro, Community-Based Production of Open Source Software: What Do We Know about the Developers Who Participate?, *Information Economics and Policy* 20 (4) (2008) 364–398.
- 860 [25] S. K. Shah, Motivation, Governance, and the Viability of Hybrid Forms in Open Source Software Development, *Management Science* 52 (7) (2006) 1000–1014.
- 865 [26] S. Spaeth, S. Haefliger, G. V. Krogh, Communal Resources in Open Source Development, *Information Research* 13 (1).
- [27] K. R. Lakhani, E. Von Hippel, How open source software works: "free" user-to-user assistance, *Research Policy* 32 (6) (2003) 923–943.
- 870 [28] E. V. Hippel, G. V. Krogh, Open Source Software and the "Private-Collective" Innovation Model: Issues for Organization Science, *Organization Science* 14 ((2)) (2003) 209–223.

- [29] A. Hars, S. Ou, Working for free? Motivations of participating in open source projects, *Intl Journal of Electronic Commerce* 6 (2002) 25–39.
- 875 [30] B. Luthiger, C. Jungwirth, Pervasive Fun, *First Monday* 12 (1) (2007) 5.
- [31] F. Fagerholm, A. S. Guinea, J. Münch, J. Borenstein, The role of mentoring and project characteristics for onboarding in open source software projects, in: 8th International Symposium on Empirical Software Engineering and Measurement - ESEM '14, 2014, pp. 1–10.
- 880 [32] I. Steinmacher, T. Conte, M. A. Gerosa, D. Redmiles, Social barriers faced by newcomers placing their first contribution in Open Source Software projects, in: *ACM Conference on Computer-Supported Cooperative Work & Social Computing*, ACM, 2015, pp. 1379–1392.
- 885 [33] I. Steinmacher, I. S. Wiese, T. Conte, M. A. Gerosa, D. Redmiles, The hard life of open source software project newcomers (2014) 72–78.
- [34] A. Schilling, S. Laumer, T. Weitzel, Train and retain: the impact of mentoring on the retention of FLOSS developers, in: 50th annual conference on Computers and People Research, ACM Press, 2012, p. 79.
- 890 [35] J. Colazo, Y. Fang, Impact of License Choice on Open Source Software Development Activity, *Journal of the American Society for Information Science and Technology* 60 (5) (2009) 997–1011.
- [36] K. J. Stewart, S. Gosain, The impact of ideology on effectiveness in open source software development teams, *MIS Quarterly* 30 (2) (2006) 291–314.
- 895 [37] I.-H. Hann, J. Roberts, S. Slaughter, R. Fielding, Economic Incentives for Participating Open Source Software Projects, in: 23th International Conference on Information Systems (ICIS), 2002.
- [38] S. Krishnamurthy, S. Ou, A. Tripathi, Acceptance of monetary rewards in open source software development, *Research Policy* 43 (4) (2014) 632–644.

- [39] M. Zhou, A. Mockus, What make long term contributors: Willingness and opportunity in OSS community, in: ICSE '12 34th International Conference on Software Engineering, Zurich, Switzerland, 2012, pp. 518–528.
- [40] T. Wang, H. Wang, Who Will Become a Long-Term Contributor ? A Prediction Model based on the Early Phase Behaviors (2018) 1–10.
- [41] J. Lave, E. Wenger, Situated learning: Legitimate Peripheral Participation, Cambridge University Press, 1991.
- [42] D. Sholler, I. Steinmacher, D. Ford, M. Averick, M. Hoye, G. Wilson, Ten simple rules for helping newcomers become contributors to open projects, PLOS Computational Biology 15 (9) (2019) e1007296.
- [43] A. G. Fink, How to Ask Survey Questions, vol 2 Edition, SAGE Publications, Inc, 1995.
- [44] E. Smith, R. Loftin, E. Murphy-Hill, Improving developer participation rates in surveys, in: 6th International Workshop on Cooperative and Human Aspects of Software Engineering (CHASE), 2013.
- [45] A. Strauss, J. M. Corbin, Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory, 2nd Edition, SAGE Publications, 1998.
- [46] J. W. Creswell, Educational Research: planning, conducting, and evaluating quantitative and qualitative research, 4th Edition, Pearson, 2012.
- [47] S. B. Merriam, Qualitative Research: A Guide to Design and Implementation, 3rd Edition, Vol. 1, Jossey-Bass, 2009.
- [48] J. a. Roberts, I.-H. Hann, S. a. Slaughter, Understanding the Motivations, Participation, and Performance of Open Source Software Developers: A Longitudinal Study of the Apache Projects, Management Science 52 (7) (2006) 984–999.

- 925 [49] M. R. Smith, Retention of Firefighters in Volunteer Fire Departments in Suburban Nebraska, Ph.D. thesis, Capella University (2014).
- [50] N. Lacetera, M. Macis, R. Slonim, Economic Rewards to Motivate Blood Donations, *Science* 340 (6135) (2013) 927–928.
- [51] P. Resnick, R. E. Kraut, Building Successful Online Communities:  
930 Evidence-Based Social Design, The MIT Press, 2009.
- [52] H. Zhu, A. Zhang, J. He, R. E. Kraut, A. Kittur, Effects of Peer Feedback on Contribution : A Field Experiment in Wikipedia, in: CHI '13 SIGCHI Conference on Human Factors in Computing Systems, 2013, pp. 2253–2262.
- [53] S. Balali, I. Steinmacher, U. Annamalai, A. Sarma, M. A. Gerosa, Newcomers barriers... is that all? an analysis of mentors and newcomers barriers in  
935 OSS projects, *Computer Supported Cooperative Work (CSCW)* 27 (3-6) (2018) 679–714.
- [54] K. Charmaz, Constructing Grounded Theory, SAGE Publications, London, UK, 2006.